ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Vol. XLVIII. No. 16.

TABLE OF CONTENTS.

(20 pages and insct.)

ENGINEERING NEWS OF THE WEEK..... 305
The Weehawken Inclined Railway (with two-page plate and other illustrations)..... 306
The Joint Use of Underground Conduits for High and Low Tension Wires 309
Annual Meeting of the American Society of Municipal Improvements 310
Highway Bridge of 465-ft. Span Over the Miami River at New Baltimore, O. (illustrated)..... 313
Determining the Size of Hoisting Plants (illustrated) 318
Electric Driving in a Belgian Steel Mill (illustrated) 321
Signals for Urban and Interurban Railways..... 322
Brazing Cast Iron by a New Process (illustrated)... 322
Annual Convention of the American Street Railway Association.... 323
EDITORIAL NOTES 314
The Anthracite Coal Strike and the Public's Rights—The Responsibility of Engineers as Impartial Arbitrators of the Labor Problem—Better Signaling Needed for Electric Railways—Concerning Some Defects in Current Electrical Literature—The Electric Motor for Driving Roll Trains—An Indictment for Conspiracy Among Bidders—Flattery from Our Contemporaries.
EDITORIAL:
Features of the American Street Railway Association's Convention. 315
LETTERS TO THE EDITOR.....315-317
Dangers of the St. Lawrence Route—Timber Lining for Canals in Earth Excavation—The First Water Closets West of the Alleghany Mountains—Forcing Cement Into Quicksand by Air Pressure—A Query as to the Value and Significance of Certain Cement Tests—A Device for Testing an Elevator Air Cushion (illustrated)—The Effect on Meadow Lands of Back Water from Dams (illustrated)—Notes and Queries.

A TELEPHONE LINE between England and Belgium will shortly be put in operation. The cable part of the line, 55½ miles in length, is completed; it extends from La Panne, Belgium, to Margaret's Bay, near Dover, England. The Belgium end will be connected with Brussels and Antwerp, but if the service warrants, the connection may later be extended to other cities. The total cost of the line will be about $400,000, which will be shared equally by England and Belgium. The toll will be 10 francs for three minutes' conversation.

STORAGE BATTERY STREET CARS used on the 34th St. crosstown railway in New York city have been a source of much complaint from passengers on account of acid fumes escaping from the batteries. The evil has become so serious that a ventilating flue to the roof of the car has been recently added with, it is said, an electric fan to force the acid fumes through the flue to the open air.

THE INTRAMURAL RAILWAY for the St. Louis Exposition will be a third-rail electric line, 9.66 miles long, and will traverse the Exposition grounds in three loops of widening circumference, which coincide at three entrances each. Each of these loops may be operated as a separate system, employing different cars. On all the loops the cars are designed to run in the same direction as the hands of the clock. The cars on all the loops are to run over the same track, at the eastern end of the grounds; this will be the starting point, and the main station for all the intramural loops, and it will be possible for a visitor to board a car there for any point in the grounds that he desired to reach. In the third-rail system to be employed, power will be supplied to the motors from a steel rail outside the track, on which the car wheels run, contact with this trolley track being supplied by a metal shoe, which slides along it. It is designed to elevate the road over all crossings, roads and avenues where possible. Where this is not possible, the third rail will be buried between the tracks the same as an underground trolley, contact being gained through a slot between the tracks.

ANOTHER FATAL COAL MINE DUST EXPLOSION is reported at Pawnee, Ill., on Oct. 13. Two men were killed outright, four others received fatal injuries and sixteen others were seriously hurt. The dust was fired--as usual --by a blast. It is stated in the press reports that the explosion swept all through the mine and the casualties among the workmen occurred at a point some 4,000 ft. from where the blast was fired.

ELECTRIC RAILWAYS are coming largely into use in Russia, says the U. S. Consul at Odessa. The first electric tramway was built at Kief in 1893; in 1898, 45 towns had constructed such lines aggregating in length 312 miles. A number of other cities are planning to use this type of traction and its use is being considered for some of the great railway systems of Russia. A chain of electric railways is being planned to connect towns on the western frontier of Russia, and another line is laid down to cross the Caucacus through the Dariel Pass, connecting the railway at or near Vladikankas with Sahkun on the south slope of the mountain. A concession has been granted for supplying electric power to St. Petersburg from the Volhov rapids at an estimated cost of $14,000,000, and the company is to provide light to St. Petersburg gratuitously. The maximum transmission distance is 188 miles.

PUBLIC WORK IN MEXICO is reported upon in the late message of President Diaz to the National Congress. At Vera Cruz, the harbor is being deepened to 9 m.; the new customs house, post and telegraph buildings are nearing completion, and work on the sanitation and water supply of the town are being pushed. At Tampico and Coatzacoalcos, wharves, piers and warehouses are being built. At Salina Cruz, the western breakwater has been carried out 343 m.; the eastern breakwater 60 m., and the provisional wooden pier, 190 m. Other harbor work is in progress at Mazatian, Manzanillo, Tuxpan and Altata. A submarine cable is being laid between Vera Cruz, Frontera and Campeche. On the Tehuantepec Railway ties have been renewed for 190 kilometers, the road reballasted for 130 km., and 80-lb. steel rails relaid for 60 km.; 350 culverts have been built and permanent bridges erected at Gumuapa, Sarabia and Tahuantepec.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision which occurred on Oct. 8, on the Pittsburg, Cincinnati, Chicago & St. Louis Ry., of the Pennsylvania Lines West of Pittsburg, near Washington, Pa. A coal train and a work train collided, and five laborers on the latter were killed.——Rather more than the usual number of train accidents with fatal results, occurred during the week, several causing the death of at least two persons. The following are more noteworthy than the others: A misplaced switch on the Highland division of the New York, New Haven & Hartford R. R., near Waterbury, Conn., on Oct. 9, caused a crowded excursion train to take a siding and collide head-on with a passenger train, which was waiting for the other train to pass. Two of the excursionists were killed in the wreck. On Oct. 8 an accommodation train on the Pennsylvania R. R. ran into the rear of a through express passenger train which was stalled at Menlo Park, N. J., because of a hot box. One person was killed. The accident occurred on straight track, in full daylight, and on a four-track line equipped with complete automatic block signals. The engineer of the moving train saw the train ahead when he rounded a curve over a thousand feet away, and he brought his train nearly to a stop before the collision. Enough impetus was left, however, to partly telescope the rear car of the standing train, and a passenger, who was endeavoring to escape from the train before the collision, was crushed.

THE MONUMENTAL BUILDINGS OF VENICE are in a very serious condition, according to a correspondent of the London "Times," in commenting on Signor Boni's work in connection with the restoration of these buildings. This correspondent says that the Church of St. Mark, the Doge's Palace, the Procurate Vecchie, the Zecca and the churches of Santa Maria Gloriosa, del Frari and SS. Giovanni e Paolo, all need prompt attention if their destruction is to be averted. In St. Mark's the great arch near the altar is cracked and sags down one foot; diagonal cracks appear in parts of the Doge's Palace and the brickwork is leaning out, and this is partly due to the late cutting through of a chief internal wall to make room for an elevator. He says that preparations are being made to remove the library from the latter building to the Zecca; but the Zecca is in such a rickety condition that the place may tumble down before the library is removed. In regard to the general subsidence of the soil at Venice, Signor Boni figures that the general surface is sinking at the rate of about 3½ ins. per century. The Biblioteca Marciana, referred to, is one of the most valuable libraries in the world and contains 200,000 books and 9,036 manuscripts of great value.

THE NEWFOUNDLAND-REID RAILWAY CASE has been decided by the arbitrators appointed, awarding Mr. Reid $854,000, or an amount representing the sum for which the Colonial Government has admitted its liability. Mr. Reid claimed $2,400,000 for work done by him; the Government passed his contracts in 1898, and the difficulties submitted to the arbitrators arose from disputed ownership of the lines in controversy.

SPECIALLY TRAINED TECHNICAL GRADUATES are applied for by "the largest trust in the United States," says Prof. R. H. Thurston, of Sibley College, Cornell University. The applicant wants graduates in chemistry, metallurgy and engineering, and promises to give college men special opportunities for one year, at a stipulated salary. Prof. Thurston thinks this application is a distinct point gained in overcoming the prejudice against college-bred men once prevalent among the large manufacturers.

A FERRY BRIDGE across the River Usk at Newport, Monmouth, England, is being built at a cost of $500,000. The site chosen for the bridge is in a bend of the Usk, which is here 240 yds. in width. The piers or towers to carry the bridge will be 250 ft. in height and the car, which will carry vehicles as well as passengers, will travel across at an altitude of 170 ft. above high-water mark. In order that the tension produced by the weight of the overhead platform, together with that of the laden car, may not be great enough to drag down the piers, the latter will be supported or stayed by steel cables extending from their summits to the ground, where the anchorage will be formed. The car for the accommodation of passengers and teams is 30 ft. long and 40 ft. wide. The central portion is for the use of vehicles. Upon the sides are covered houses for pedestrians—one quite elaborately constructed and furnished for the use of first-class passengers, the other a simple shelter for those of the second-class.

THE LARGEST TANK STEAMER AFLOAT is said to be the "New York," which has just arrived at New York from Shields, England. She has a carrying capacity of 8,800 tons on 25 ft. draft. The "New York" is 428 ft. long, 54½ ft. beam, and 32 ft. deep to upper deck. The vessel is owned by the American Petroleum Co., of Rotterdam, and is intended for the Atlantic trade.

OIL FUEL FOR NAVAL USE cannot compete with coal, is reported to be the opinion of the Board of Naval Engineers which has lately been testing oil-burners of various makes. A preliminary report on 14 devices tested says that none would burn oil under a naval boiler and produce steam in competition with coal, even when the oil sold at $1 per barrel. The report of Lieut. Ward Winchell, U.S.N., on the "Mariposa" trial gives the following items: The "Mariposa" has a gross displacement of 3,160 tons, and the average horse-power developed was about 2,481. The average daily run was 354 knots, giving a mean speed of 13.58 knots; 278 bbls. of oil were consumed each day, or 3,720 lbs. per hour. It practically required 1½ lbs. of oil per hour to secure 1 HP., or about 50% less in weight of combustibles than would be required of coal. The ship made the trip from San Francisco to Tahiti in 262 hrs.; the return voyage was made in 260 hrs.; the distance being 3,438 miles one way. Careful inspection showed no bad effect of the flame on any part of the boiler; and after the run to Tahiti—3,438 miles, all the refuse swept by scrapers from the tubes barely filled two ash buckets. The principal difficulties encountered were in the direction of regulating the supply of oil to the heaters by the pumps, and some trouble arose from the choking of the strainers by impurities in the oil. The shorter time expended on the return trip was due to the fact that the firemen became better accustomed to manipulating the burners.

AMERICAN COAL STATISTICS are set forth in the "Mineral Resources of the United States for 1901," now in press. In the anthracite coal fields in 1900, 144,206 men working 166 days, produced 57,367,915 short tons of coal, valued at $85,757,851; or, 2.4 short tons per day per man. In 1890, in the same field, 126,000 miners working 200 days produced 46,468,641 short tons, valued at $66,383,772; the average production being 1.85 short tons per man per day. The average price of anthracite coal at the mines, per short ton, was—1890, $1.43; 1895, $1.41; 1900, $1.49; 1901, $1.67. In 1901, with 145,309 men working 196 days, 67,471,667 short tons of coal were produced, valued at $112,504,020; the average output per man per day was 2.36 short tons. The bituminous coal output for 1901 was 225,826,849 short tons produced in 225 days by 340,235 men; the average rate being 2.94 short tons per man per day. This coal was valued at $236,406,449. The output in 1890 was 111,302,322 tons, valued at $110,420,801. This was mined by 192,204 men, working 226 days; or at the rate of 2.56 tons per man per day. The average price at the mines of bituminous coal per short ton was—1890, 99 cts.; 1895, 86 cts.; 1900, $1.04; 1901, $1.05. During 1901, in the bituminous mines, 954 men were killed, and 2,400 injured by accidents, in a total of 340,235; in the same year in the anthracite mines 513 men were killed and 1,234 injured in a total of 145,309 employed.

THE TIMBER RESOURCES OF WASHINGTON are given in Professional Paper No. 5, of the United States Geological Survey. The total timber standing is 195,688 million feet B. M. Half the entire area of Washington is forest covered, 51% of the timber being red fir. Since lumbering began in Washington 30,000 million feet B. M. have been cut and 43,000 million feet B. M. have been destroyed by forest fires.

THE WEEHAWKEN INCLINED RAILWAY.

By Charles L. Duenkel, M. E.*

(With two-page plate.)

The lower reach of the Hudson River is bordered on its western side for a distance of some 20 miles above the city of New York by a steep dike of trap rock several hundred feet high—the famous Palisades of the Hudson. This dike forms an effective barrier to communication between the river front and the country above the cliff, which is of particular importance at the location of busy towns and cities. Thus, at Hoboken, opposite the central portion of New York city, communication between Weehawken, on the river front, and West Hoboken, at the top of the hill, has been obtained for years only by means of a steep and circuitous road, which heavily loaded teams cannot traverse in much less than one hour. For a long time it has been evident that some better means of transportation at this point was necessary, but it was not until the year 1898 that anything definite was accomplished. In that year Mr. A. S. Niven interested some local capitalists and organized the New Jersey Elevating & Transportation Co. for the purpose of building the inclined railway which forms the subject of this article and which is now in successful daily operation.

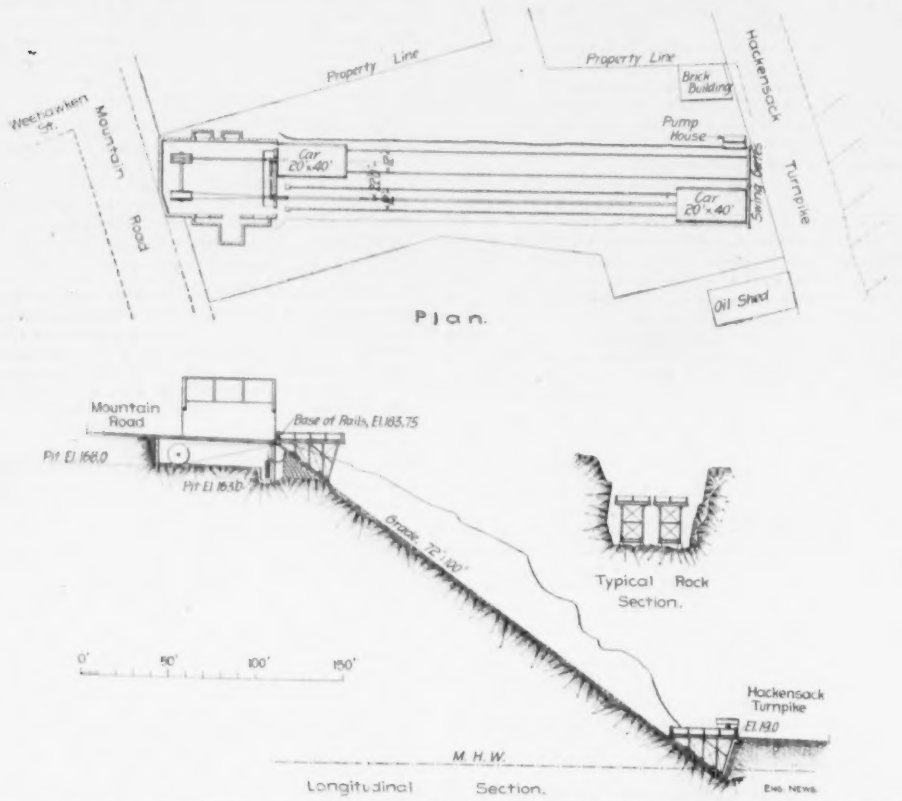


FIG. 1. PLAN AND PROFILE OF WEEHAWKEN INCLINED RAILWAY, BETWEEN WEEHAWKEN AND WEST HOBOKEN, N. J.

The incline runs from the Hackensack Turnpike at the lowlands to the Mountain Road at the top of the Palisades. Its total rise is 166.3 ft., its horizontal run 231 ft., so that the total length of travel of the cars is about 285 ft. The grade of the line is 72 ft. in 100, equivalent to an angle of 35° 45', making it the steepest inclined railway in the country.

The incline has two tracks, upon which two cars are run, one ascending as the other descends. Each car is a large horizontal platform capable of holding a number of teams. The traffic consists principally of food-stuffs and merchandise to supply a well-built-up area of several square miles on the crest of the hill. There is also a large amount of trucking for the breweries in the vicinity, so that the cars are kept in constant service during the greater portion of the day. The cars are hauled up the incline by cable. The operating machinery is located in the space below the roadway of the landing house at the top.

The excavation for the inclined roadway is 50 ft. wide, and at the highest point is 40 ft. deep. The roadway forms a pit at the bottom of the incline, into which the cars descend so as to bring their platforms on a level with the lower landing. This pit is about 29 ft. deep; it is drained by a small centrifugal pump driven by a 3-HP. electric motor.

A plan and profile of the inclined railway is given in Fig. 1. As will be seen, it comprises the inclined tracks, a landing pit and platform at the bottom, a landing house at the top, and the cars and operating machinery. A general view of the incline, as seen from below, is shown in Fig. 2. The farther or north car is here shown near the bottom of its travel; the pit is located behind the landing in the foreground.

The two cars are connected by a cable leading over idler or balancing sheaves at the top, so that their dead weight is always balanced. Two other cables from each car lead to the winding drums of the hoisting machinery, which latter has only the live load on the cars to take care of. On account of the steepness of the incline and the heavy loads to be carried, an abundance of safety devices is provided in connection with the hoisting machinery, designed to ensure perfect control over the movement of the cars at all times and under all conditions. The operating machinery is further of interest because it is electrically driven throughout. Direct current at 550 volts is supplied to the railway by the United Electric Co. of New Jersey, a corporation which furnishes current for lighting the city of Hoboken and for operating the trolley roads in the neighborhood, but the inclined railway takes its current over an independent metallic circuit. Special interest attaches to the fact that this railway is electrically driven because of the requirements of the case as to accuracy and certainty of control under widely varying conditions. It became necessary to provide landing rams auxiliary to the winding machinery, and to arrange an elaborate system of hoisting-motor control to ensure the cars coming within the range of the landing rams under all conditions of load, etc. The cars are operated from a pilot house on the main floor of the landing house, from which the operator has a free view over the whole track. The following is a brief description of the principal features of the plant:

CARS AND TRACK.—The tracks have a gage of 12 ft., and are spaced 22 ft. between centers. The rail used weighs 58 lbs. per yd.; it is supported directly on concrete stringers resting on the native rock. The two rails of each track are tied across at intervals of 36 ins. by ties made of 6-in. channels bedded in the stringers with flanges down and bolted to the concrete by anchor bolts. The general arrangement of the track can be seen in the view Fig. 3; the detail construction is shown in Fig. 4. As will be noted, idler sheaves for supporting the cables are set between the rails at intervals of about 20 ft. At these points the ties are spaced only 24 ins. and stirrup hangers are bolted between them, on which the sheave bearings are supported.

Fig. 4 also shows the detailed construction of one of the cars. The cars as well as the operating machinery are figured for a maximum unbalanced live load of 40,000 lbs. The platform of the car is supported by two triangular truss frames built up of structural steel shapes and rigidly cross-braced together. At their lower ends these frames rest each on four wheels running on the track rail. The detail of this attachment is shown to larger scale at A in Fig. 4. The lower chord channels of the trusses are spaced far enough apart to admit the standard 33-in. freight car wheels between them. Journal boxes and springs, both railway standard, support yokes from which the truss is suspended.

At the top the trusses are connected by double-channel floor beams. The floor stringers are of 3 × 12 yellow pine, except two of them, spaced 58 ins. on centers, which are 6 × 12 ins. in size, to support trolley tracks which it is expected will be carried in the near future. The flooring consists of two thicknesses of 2-in. yellow pine plank. Yellow pine guard rails are provided at the sides, and a lattice railing runs along their top. The platform is 40 ft. long and 18 ft. wide between guard rails. The two ends are closed by folding gates, double chains being fitted in addition. There are two other safety provisions at each end. One of these is a wrought-iron pipe rail extending across in front of the gates; it is hinged at one end and counterweighted. The other is a wheel-chock; one of the floor planks is hinged and fitted with a hand-lever, so that it may be thrown up as a wagon stop. The latter device has been found unnecessary, loose wheel-chocks used on all teams being sufficient for safety. The total weight of each car, unloaded, is about 40 tons. As already noted, its carrying capacity is 20 tons.

The attachment of the hoisting and balancing cables to the car is shown in the plan view of the lower part of the car frame in Fig. 4. A truss 8 ft. deep lies in the plane of the top flanges of the lower chord of the car frames; the three cables take on to this truss by means of long screws connected to the cables with clevises. The screws pass through the truss and bear against its lower chord by wormwheel nuts; a short worm meshes into each wheel, and is fitted at its upper end with a square head for a socket wrench. By means of these worms each cable can be adjusted independently, even when the car is in motion. Such adjustment is necessary to compensate for the stretch of the cables, since the length of the cables must always be such that when one car reaches the bottom the other just reaches the top of its travel.

OPERATING MACHINERY.—The operating machinery, as already noted, is contained in the space under the roadway of the landing house. A plan of this machinery room is shown in Fig. 5, a vertical section of the room on the center line of the railway in Fig. 6. The inclined tracks drop away to the right in both figures. The cables from the cars pass into the house over leading-in sheaves projecting partly outside of the house; from there the two hoisting ropes of each car run back to the hoisting drums on the left. The middle rope from each car drops down vertically from the leading-in sheave, and after winding several times around a set of balancing sheaves it joins the corresponding cable from the other car. These balancing sheaves are fitted with a band brake under the control of the operator in the pilot house, by means of which the cars can be held at any desired point.

*120 Liberty St., New York city.

The hoisting drums are keyed to a common shaft, but are driven by separate electric motors through separate triple-reduction gear trains. Each of these motors is fitted with an automatic brake.

The landing rams which have been mentioned are four in number, one being located at the upper end of each rail and in the line of the rail. Their plungers are fitted with hooks adapted to engage the interior. The cables take 2⅛ turns around the drum for a hitch, and their ends are passed through the rims and secured by babbitted clevises. A cast gear, made in a single piece, is bolted to the inner flange of each drum and connected by triple-reduction gearing with the motor.

The motors are of the Westinghouse make, compound wound, and in common with all the electrical machinery, take the full line-pressure of brake-band. The windings of this magnet are double, with one coil in series with the motor armature and the other coil shunted across the armature. The latter winding is insufficient to release the brake, but will hold it off when once released. By this arrangement the brake is kept off until the motor is finally stopped, but the release will not act if the current should be turned on while the armature is out of order so that the

FIG. 2. VIEW OF WEEHAWKEN INCLINED RAILWAY FROM BELOW.

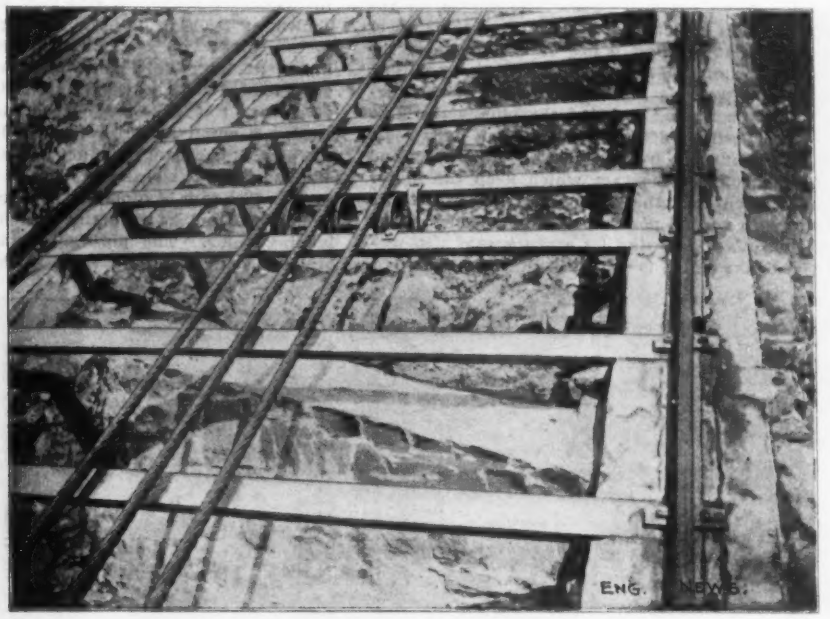


FIG. 3. VIEW OF PORTION OF TRACK.

projections on the under side of the car. When a car approaches the upper end of its travel, automatic devices bring it to a stop at a point somewhere within the reach of the rams. The operator then starts the two rams belonging to this car, and they pull the car up the remaining distance. The rams are shown in their proper relation to the car in Fig. 4. They are operated by oil, and this is supplied by a weighted accumulator fed by a pump driven by a small electric motor. The pump and accumulator are set along the north wall of the machinery room, and will be seen in Figs. 5 and 6.

The electrical devices forming part of the machinery comprise the hoisting motors, with their electro-magnetic brakes, a complete automatic switch-control system for these motors, the pump motor and automatic starting and stopping switches for same, a pilot house controller and the necessary circuit breakers, fuses, measuring instruments, etc. The most interesting part of this equipment is the automatic control for the hoist motors; the arrangement of switches used for this is similar to that used in automatically controlled electric elevators, but embodies some important additions, as will be brought out farther on. These control switches and their corresponding resistances are mounted on a switchboard which stands just west of the oil pump that supplies the rams. Behind this switchboard is a smaller one, which carries the main fuses, meters small lighting switches, etc.

The preceding general description will make clear the disposition of the different parts of the operating machinery. Some of these parts merit a more detailed description.

The hoisting drums are, as already noted, mounted upon a common shaft. The drums are 12 ft. in diameter by 4 ft. 8 ins. face, grooved for 2-in. cables, the scoring being right and left-handed from the center line. One cable follows each groove, so that the pull on the drum is at all times central. The two drums being exactly similar, the cables from one car lead over, those from the other car lead under, their respective drums. The drums are of cast iron, each being made in three pieces, a single rim casting, and two solid plate webs, each bearing a half length of the hub; manholes in the webs give access to

550 volts. They have each a normal capacity of 135 HP., but will stand a 50% overload; thus a maximum of 400 HP. is available for hoisting. They are designed for either parallel or series connection, with a normal speed in parallel of 600 r. p. m.; at present, however, they are being run in series, since this is considered more suitable under present conditions of traffic.

The motor shaft is fitted with a "magnetic brake." A brake-wheel is mounted on the shaft

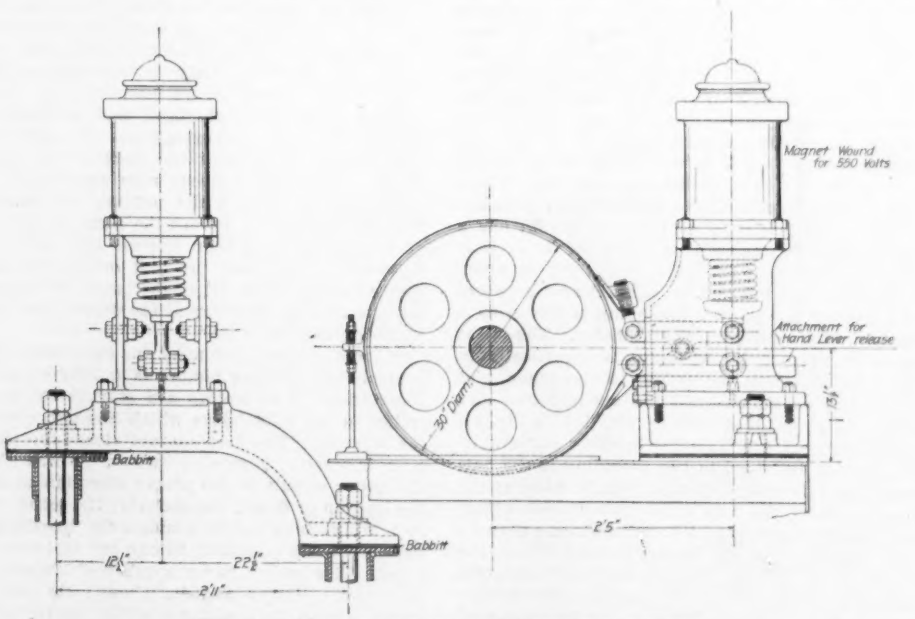


FIG. 7. MAGNETIC BRAKE FOR HOISTING-MOTORS.

just outside the driving pinion, and a brake-band of steel, lined with hard fiber, surrounds it. The brake, acting on this band, is shown in Fig. 7. A spiral spring normally draws the brake-band tight around the wheel, but when current flows through the armature of the hoisting motor it energizes the coils of a magnet contained in the case above the brake spring and releases the motor would not work. In this way an accident is avoided which might result from a loaded car starting down by gravity before the motor operates. The levers of the brake are arranged so that a long hand-lever may be applied to release the brake and slowly let the loaded car to the bottom in case the cars should be stalled on the incline.

The general disposition of one of the drums with its motor, gearing and brake, is illustrated by the view Fig. 8. All parts of this hoisting machinery are fastened to a rigid foundation frame of steel girders, which in turn is anchored securely by bolts passing through a concrete foundation into bedrock.

The landing rams, whose function has been described, are shown in detail in Fig. 9. The cylinder of the ram is of cast iron, with a bore of 6½

ins.; the plunger is of hammered steel, 6 ins. in diameter by 3 ft. stroke. At its upper end it carries by means of a crosshead two ⅞ × 5-in. steel bars, whose lower end is formed into hooks, as shown in the drawing. The bottom edge of these hooks slides on guides cast on the top surface of the cylinder. Two steel channels support the ram, and serve to secure it to the landing masonry at the upper end and to a strong rock anchorage at the lower end. The guides for the hooked bars are curved downward at their lower end, so that the first 6 ins. of the stroke of the plunger brings the hooks up to operating position, leaving a working stroke of 30 ins. A counterweight is arranged to bring the plunger back to normal position after completion of its stroke. Electric contacts are provided at the bottom end of the hooks of the ram which keep the motor circuit open until the plunger has returned to its bottom or normal position. A view of one of the rams in place, showing its arrangement with respect to the track, is shown in Fig. 10.

leading-in sheaves down to the car. The detail A, Fig. 12, shows a section through the rim of one of these drums. The cylindrical extension on one side of the rim is embraced by the brake-band, which consists of a 6 × ½-in. steel band lined with fiber blocks 6½ × ⅝ × 4 ins. The sections of the brake-band around each wheel are joined at the top by a 1¾-in. round tension rod. Their bottom ends are carried up between the wheels to the safety brake. A side view of the latter is shown at B, Fig. 12. An equalizing lever, attached to the two sections of the brake-band, is linked at its middle point to a weighted lever arm, loaded with a weight of 2,000 lbs., which gives a pull of 3,800 lbs. on the loose end of the band. A small ram, 3¾ ins. in diameter by 3 ins. stroke, is arranged to act against this weight and thus hold the brake off, as will be seen in the detail. The ram is supplied by oil under pressure from the same accumulator which supplies the landing rams. The pipe supplying oil to this brake is controlled by a valve in the pilot house,

current, the magnet then throws its first l[ever] which cuts out some of the resistance in s[eries] with the motors. The motors now being u[nder] higher pressure, begin to accelerate at a r[ate] depending upon the load on the cars and whe[ther] the excess load is up or down. As they spee[d] the counter e. m. f. rises, and therefore the c[ur]rent flowing through the windings of the sw[itch] magnet increases. This switch is so arran[ged] that its six levers are actuated by differ[ent] amounts of current in the magnet coil. Thus, t[he] first lever will be thrown by a small current, t[he] second requires a greater current, and so on. T[he] levers are arranged to cut out successive resi[st]ances in series with the motors. When, there[-]fore, the speed of the motors has risen sufficiently, the second lever of the accelerating switch throws over and cuts out another section of resistance; this again farther accelerates the motors until the next switch lever is thrown. The same succession of operations continues until the motors are under full line potential and are running at full

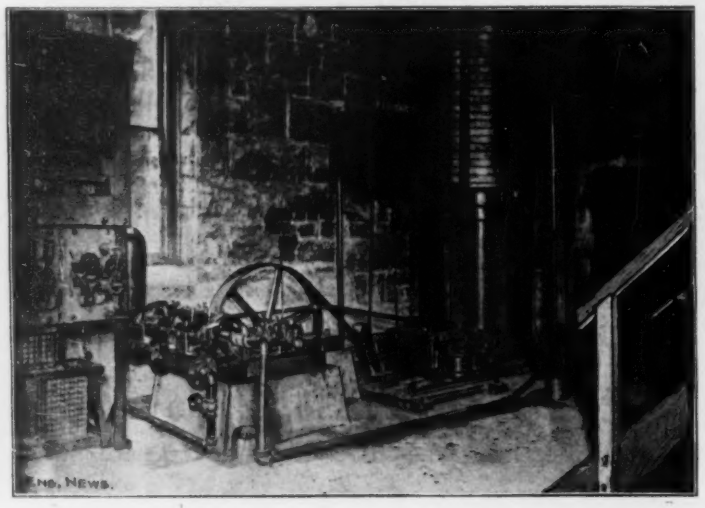


FIG. 11. VIEW OF OIL ACCUMULATOR, PUMP AND MOTOR; PART OF MAIN SWITCHBOARD AT LEFT.

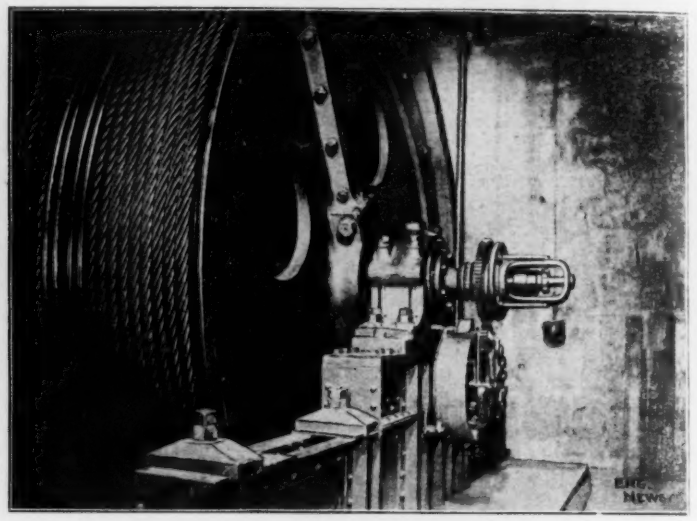


FIG. 14. AUTOMATIC STOP-MOTION IN PLACE.

The rams are operated under a pressure of 750 lbs. per sq. in. Each ram has a lifting capacity of 10 tons, the maximum live load on the car being 20 tons. The oil supply pipes leading to the rams pass through the pilot house, where the pipe for each of the two sets of rams is provided with a valve under control of the operator. When this valve is closed, after the car has reached its upper position, the counterweight on the plunger draws the ram back to normal position, forcing the oil into an open discharge tank, from where it is pumped back into the accumulator. The accumulator which supplies the pressure oil has a diameter of 7½ ins., with a stroke of 5 ft. It is charged by a 2 × 4-in. Worthington triplex pump capable of working against a maximum pressure of 1,500 lbs. per sq. in. The pump is driven by a 7½-HP. Otis compound wound motor. The latter is arranged to start and stop automatically in three speed stages, according to the amount of oil in the accumulator. The accumulator and pump equipment is shown, as installed, in Fig. 11.

Entirely separate from the hoisting and auxiliary devices described in the preceding is the balancing or safety arrangement which balances the dead loads of the two cars against each other. As already mentioned, this contrivance embraces two sheaves or short drums, around which the balancing or middle cable of one car leads over to the other car. These two drums are fitted with a safety brake. The location of the drums can be seen in Figs. 5 and 6, where they are shown at the right of the drawing just inside the east wall of the machinery room and between the lines of the two tracks.

Their arrangement is shown more clearly by Fig. 12, where the drums and the balancing rope are indicated by broken lines; the full lines show the brake-band and the brake. The 2-in. steel cable makes 2½ turns around both drums, passing upward at both ends and thence over the so that the operator can at any time throw the brake into action.

It will be remarked that these balancing drums turn alternately one way and the other as the cars go up and down; the pull on the brake-band must then be alternately on one end and the other. The figure shows how this is accomplished. The pedestal stand that supports the brake lever has side extensions, through which pass the clevis rods at the ends of the brake-band. The nuts on these rods have only very little clearance above the pedestal brackets, so that as the one car lowers the nuts on that side of the brake-band bear against the top of the pedestal bracket and the pull of the weight is exerted on the loose end of the band. This pedestal, and also the bearings of the drums, are firmly anchored to rock.

Of the electrical equipment the apparatus which controls the hoisting motors is worthy of special description. The motors are started by a controller in the pilot house which has two contacts for starting. The first contact closes the circuit of a magnetic "reversing switch," which closes the motor circuit in the proper direction to move the load up or down, respectively; the second contact brings into action a magnetic "accelerating switch," which gradually brings the motors up to speed. This switch has a number of levers operated by an electro-magnet, whose coils are connected across the terminals of the motor armature. When the motors are started by the reversing switch (through a large series resistance), they acquire a certain low speed of revolution, and thereby set up between their armature terminals a small counter e. m. f., which is only a fraction of the full-load e. m. f. When the accelerating switch is brought into action by the second controller contact, a small current, due to the armature counter e. m. f., will flow through the coils of the switch magnet. Energized by this

speed, the sixth, or last, lever cutting out the series fields of the motors and leaving only the shunt windings in action. It will be seen that the rate at which the motors are allowed to accelerate is governed by the load, and that in this way the motors are never under greater potential than they can safely carry with the speed at which they are then running.

An equally important question as that of proper starting is that of stopping the cars. It is necessary that the cars be stopped at all times within the last 30 ins. of their travel. If they should stop before this point, the landing rams would be unable to catch them and draw them up to the landing; if they should overrun, they would bump into the end abutments, which, on account of the great weight of cars and load, might result in a serious accident. It was not considered safe to trust the operator (in the pilot house) with this stopping, and it was therefore necessary to make provision for an automatic stop. If it be remembered that a maximum unbalanced load of 20 tons may be on the system, and that this load may be moving either up or down, the difficulty of providing for such accurate stopping will be appreciated.

The automatic stop mechanism comprises two separate parts: (1) a mechanically actuated stop motion connected with the winding drums; (2) a magnetic "load switch," which controls the motor connections directly. The stop motion is shown in detail in Fig. 13. It is fastened to one end of the shaft on which the winding drums are mounted. The view Fig. 14 shows it in position on the end of the shaft. Referring to the drawing Fig. 13, A shows a screw secured to shaft in prolongation of its axis; B is a nut arranged to travel on this screw. The casing D is carried by the screw, and at its rear end is fitted with a gear which is connected through an intermediate gear and pinion with the segment E of an electric switch. The

traveling nut B has projections which engage longitudinal slots in the casing, so that when the casing is held any rotation of the screw A will cause nut B to travel along the screw. This is just what takes place when the drum shaft turns in the operation of the cars. A weight acting on a cord coiled on the small sheave F, fastened to the casing, is sufficient to hold the casing against any slight turning moment, and thus the nut is forced to travel along the screw. This continues as the cars move along in their trip until nut B strikes against the fixed collar C, which is fastened firmly to the screw. At this point the projections on the nut will compel casing D to turn with it, and by means of the gears to rotate the switch segment E. The gearing is so arranged that one half-revolution of the drum shaft will move the switch segment over one notch. The switch, through the agency of the automatic "load switch," brings the hoisting machinery to a stop. At the beginning of the return trip the weight on the cord, which was coiled up on sheave F when casing D rotated, turns the casing, and

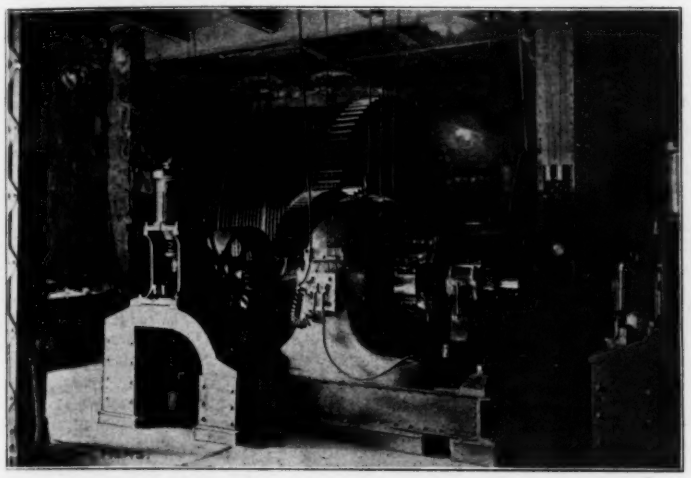


FIG. 8. VIEW OF WINDING DRUM, MOTOR AND BRAKE.

with it the switch segment, back to the central position.

The load switch is a magnet switch, quite similar to the one provided for starting the motor. An electro-magnet, whose coils are connected across the motor armature terminals, is arranged to actuate six levers, which levers control sets of resistances in series with the motor and other resistances in parallel with it. As in the accelerating switch, the current flowing through the coils of the magnet depends upon the counter e. m. f. in the armature of the motor. The switch levers control the motor in two ways—by means of series resistances they cut down the current drawn from the line at a rate depending upon the load, and by appropriate shunt resistances they produce, if necessary, a strong braking action by short-circuiting the armature. The latter action is evidently required in case of heavy loads being lowered, the former in case of loads being hoisted.

The operation of the stop motion and load switch is briefly as follows: When the stop motion rotates its switch segment to the first notch, it connects a resistance in series, and another in parallel with the motor. This cuts down the current drawn from the line and also the line pressure across the motor terminals, and the motor then drops in speed a greater or less amount as determined by the load. This speed change will have taken place by the time the stop motion switch moves to its next notch, which occurs after half a revolution of the drum shaft. This second contact of the stop motion brings the load switch into action. The successive levers of this latter are actuated by increasing amounts of counter e. m. f. in the motor armature. If, now, a heavy load is being lowered, all the levers will be thrown at once, which introduces a large increased series resistance into the motor circuit and cuts down the parallel resistance so as to develop the maximum braking current. With a smaller load going down, only a few of the levers will be thrown, and a braking action is set up in proper proportion to the load. If a load is being hoisted, none of the load switch levers are thrown, and the motor continues to run at low speed under reduced pressure. Finally, the stop motion moves to its last notch, and the line current is entirely shut off, while simultaneously the brakes on the hoisting motors go into action and bring the cars to a stop.

To bring the cars up to their landing, the operator in the pilot house now opens the supply valve of the hydraulic rams, which, as already explained, draw the car up the remaining distance. During this motion the motor brakes are released. Electrical contacts are provided, which, when the valve lever is thrown full over, close the line circuit through the windings of the brake magnets and thereby release the brakes. Closing the valve again throws the brakes into action.

It may be noted that the pilot house controller is arranged so that the operator can slow down and stop the cars at any time, but this is regarded only as an emergency device, to be used in case of accident or failure of the machinery. As another safety provision, the automatic stop motion on the drum shaft is provided in duplicate (the second device being slightly different from the one described), so that if one should fail to operate the other will bring the cars to a stop.

The incline is operated continuously six days of the week, from 6 a. m. to 7 p. m., with an average of over 100 trips per day. The time required for one trip is: Accelerating, running and slowing down, 1 min. 50 secs.; drawing cars to landing by means of rams, 12 secs.; or total time of trip, about 2 mins., for an average load of 12 tons going up. The maximum speed of the cars is about 150 ft. per min. The rams require nearly half a minute to return to normal position, before which the cars cannot be started, but this time is more than covered by loading and unloading. The tolls charged vary from 2 cts. each for foot passengers and 5 cts. each for wheelmen to 25 cts. for a double truck going up, or 15 cts. for the same going down. Special rates are made for heavy loads, long timber loads and the like.

The cost of the whole incline, ready for operation, including land damages and cost of approaches at top and bottom, was $170,000. Of this sum the operating machinery, rope and cars cost about $32,000.

The general design and specifications for this work were developed by Mr. Thos. H. McCann, M. Am. Soc. C. E., engineer for the owners, the New Jersey Elevating & Transportation Co. The contractors for excavating and grading were the Sandford & Stillman Co., of Jersey City, N. J., who also laid the tracks, built the power house and erected the machinery. The machinery was furnished by the Otis Elevator Co., built from designs made by the writer, under the supervision of Mr. Thos. E. Brown, M. Am. Soc. C. E., Chief Engineer. The electrical equipment was designed by Mr. J. D. Ihlder, Chief Electrical Engineer of the Otis Elevator Co. The writer acted as resident engineer for the latter company in the installation of the machinery.

FIG. 10. VIEW OF ONE OF THE LANDING-RAMS IN POSITION.

THE JOINT USE OF UNDERGROUND CONDUITS FOR HIGH AND LOW TENSION WIRES.*

By Chas. F. Hopewell, S. B.†

The dangers incident to conduit operation are two, namely; explosions and burnouts. While to many they appear as the same, yet nevertheless they are distinct from each other. An explosion in a manhole, where it almost invariably occurs, is due to the ignition of gas which has accumulated there. The gas can be ignited by an electrolytic spark from a cable sheath or from the wheels of a passing car or other causes. The result is generally the blowing off of the manhole cover, but it seldom results in damage to the cables. These are liable to occur in telephone conduits as readily as in electric light conduits. This might be called an exterior cause. Burnouts can be classed as interior causes, due to the breakdown of insulation in the cables, resulting in the melting or breaking down of the cables themselves. A distinction should here be made between electric light cables and railway feeder cables. In the former case a breakdown results in a ground and not necessarily in a short circuit, consequently it does not infer a burnout except in the case of an Edison system with its neutral grounded mains. Of course if there is another ground on a circuit at the time the breakdown occurs, you will then get a burnout, but this should be very rare. In the railway system this is different, as one side of the circuit always remains grounded, so that a breakdown almost always leads to a burnout. The severity of this burnout depends entirely upon the method of operation of the system. These burnouts result in heating the air in the manholes and blowing off the cover. The results are much more serious in many cases due to faulty method of construction and faulty operation. The Edison tube system I shall not consider, as it is already an obsolete system and is fast disappearing.

Faulty method of construction I consider to comprise all kinds of conduit built of conducting material, such as iron pipe, or ducts with an iron covering where joints every 8 ft. place the cable in contact with iron rings metallically connected to such iron cover. In this class of construction, you will readily see that a breakdown of insulation immediately charges the entire conduit from manhole to manhole. The current then flows through the breakdown to conduit and from conduit to the lead sheath of the other cables, thereby destroying them. In tile conduits there is no such liability, for it cannot exist.

I have never been able to learn of a breakdown in a cable in one vitrified duct passing directly to a cable in another vitrified duct, unless such passage of current took place in a manhole. There has never been a burnout in Cambridge, although the Boston Elevated Railway Co. have 21 miles of tile duct in this city and have had cable in it since 1897. Moreover, there has never been a burnout in Roxbury, a part of Boston, where such a construction is used, where a defect in a cable in one duct has led to the using of a cable in another duct. There have been many instances of burnouts in Boston where the current has passed from one cable to another, but they have al-

*Abstract of a paper read before the International Association of Municipal Electricians, Richmond, Va., October 7 to 9, 1902.

†City Electrician, Cambridge, Mass.

ways been in cement conduit having an iron shell. All the Boston Elevated Railway burnouts have occurred in conduits of such construction.

Cables, instead of being systematically separated in manholes, have been laid up together, whereas they should all be insulated from each other, but, of course, bonded to a ground return wire capable of taking the current of any one cable to such ground return, rather than allowing it to pass to any other cable sheath. This bonding is necessary to prevent electrolysis.

Faulty method of operation, which has been the cause of a large number of burnouts, consists in not properly watching the cables and forestalling a breakdown in insulation in the same where the insulation shows deterioration. Another very prolific source of such trouble is the method of throwing the circuit breakers at the central station back in again when they have once opened. I have known of an instance in Boston where a circuit breaker was held in until it burnt out in the hand of the attendant.

In the serious burnout in Boston on the street railroads in times past, at Summer St. and Atlantic Ave., we found that both conditions were present, namely, faulty construction, as well as faulty method of operation. The Boston Elevated Railway Co. have since given up the attempt to burn out a cross on their feeder and now leave their circuit breakers out after three attempts to close them. Formerly they lined up their operators at the switchboard and threw the circuit breakers in and thus sent their entire central station energy through the cable breakdown in order to burn it clear.

I will now consider, from the standpoint of practice rather than theory, what the requisite separation should be between the high and the low-tension wires to ensure perfect safety. In joint conduit construction there are two classes of construction differing only as to whether all the cables enter the same manholes or whether separate manholes are used respectively for the high and low-tension wires. If each corporation operating cables possess individual manholes then such a system will fall under the latter category.

In proof of my contention of the practicability of such a system for joint occupancy by high and low-tension wires, I desire to bring forth the actual condition of construction and operation as found in practice in many of our cities. If it can be demonstrated that such joint occupancy is safe and practical in these cases, it will necessarily follow that such construction will be safe and perfectly satisfactory wherever adopted.

I will cite the following cities as possessing conduits jointly occupied by both classes of cables:

NEW YORK CITY.—Mr. C. I. Walker, Chief Engineer of the Empire Subway Co., has publicly stated in a hearing at the Massachusetts Legislature that there are over twenty miles of conduits in New York city where the high-tension ducts are directly over the low-tension ducts, with only a 6-in. concrete separation between these ducts. There was also a mile where the two classes of ducts were laid side by side with a separation of 14 ins. These ducts were, moreover, of iron.

CAMBRIDGE, MASS.—The West End Street Railway Co. constructed in 1897 a mile of conduit for their own wires, and wherein the city was given two ducts. The city ducts enter separate manholes built by that company especially for the use of the city. These city manholes are now connected with manholes of the telephone conduit on the same street for the purpose of carrying the city wires from one conduit system to another. Mr. Walter R. Eaton, the Chief Electrical Engineer of the Cambridge Electric Light Co., has publicly stated that a combined conduit system using separate manholes was practical.

PHILADELPHIA.—David R. Walker, for twenty-five years head of the Electrical Bureau of Philadelphia, has stated that the electric light and telephone wires have been in successful operation in adjacent ducts in Philadelphia for over ten years. The ducts used were of wood or tile and the cables entered the same manholes.

ROCHESTER, N. Y.—In Rochester, N. Y., the Rochester Telephone Co. have had over 250,000 ft. of telephone cable in electric light ducts since May, 1900, and are installing 80,000 ft. more. They have experienced no difficulty in operation, although their cables enter the same manholes with the electric light wires.

CHICAGO, ILL.—In Chicago over 100,000 ft. of high and low-potential cables have been in successful operation for the past ten years, some of the cables carrying current at 8,000 volts. These cables occupy the same manholes with the low-tension wires, but are grouped on separate sides of the manholes. On Archer Ave., the Railway Co. and the city have built a combined conduit system at a very large saving in cost over a separate system.

BALTIMORE, MD.—There are in use to-day over 5,000 ft. of conduit used in joint operation by the high and low-potential wires and occupying the same manholes. The conduit is owned by the city.

The subject of the practicability of the operation of high and low-potential wires in the same conduit has been investigated by two expert and competent commissions. One appointed by President Harrison in 1891, for Washington, D. C., recommended a general conduit system with separate manholes for the high and low-potential wires and the ownership to be by the city.

Another commission, appointed in 1896 to consider the subject of conduits for Baltimore, recommended a general municipal conduit system. Baltimore has already expended over $600,000, out of an appropriation of $1,000,000, for such construction. They have installed a combined conduit system with single manholes of large size.

In many other cities of this country conditions will be found where high and low-tension conduits are laid side by side or cross each other, so that to all intent and purposes they might have been installed as one conduit system as far as any question of safety was concerned. In Boston many cases of this kind occur, notwithstanding the fact that each conduit was laid separately.

It is good logic to say that if high and low-tension wires can be placed within 6 ins. or 1 ft. of each other without danger, then it must follow that there is no advantage in placing them any farther apart.

In concluding my discussion of the engineering features of conduit construction, I will state what I believe to be the best practice regarding such installation:

The conduits to be installed for all classes of service as a single conduit system with a double set of manholes. The system to have a subsidiary distributing system to contain only low-tension wires.

The conduits should be built of non-conducting and permanent material, preferably of tile. Single ducts to be used for high-tension wires, as it gives a double wall between ducts. Low-tension ducts to be of the multiple type. The low-tension ducts to be laid on top of the high-tension ducts and separated therefrom by 6 ins. of concrete cement. (This would not be necessary if proper method of operation were insisted upon.) The distributing ducts to be laid on top of the low-tension ducts. The entire duct system should be imbedded in 3 ins. of concrete cement, with a 1-in. plank on top. For wide streets a double system of distributing ducts may be necessary, and these should be located one on each side of the street. The subsidiary ducts to enter handholes placed as far apart as possible, yet close enough to prevent any lengthy street excavation for service connection, but not nearer than every other lot line.

The manholes to be installed at street corners as far as possible. One set to be for all high-tension wires and the other set for low-tension wires. The high-tension manholes to be of sufficient size to contain transformers and other devices, as only low-tension wires are to enter the distributing system. Cable in all manholes and handholes to be systematically installed on insulating hangers or shelves.

A system of regular inspection of manholes and handholes should be enforced.

A system as outlined above would do away with the objection raised by Referee Hancock in the case of the Bell Telephone Co. vs. the City of Rochester, and which was decided in favor of the company last April. The court held in that decision that it was dangerous to place high and low-tension wires in the same conduit system with same manholes under the conditions as they exist in Rochester. The court stated, however, that "No hard and fast rule can be laid down on this particular branch of the controversy. Circumstances and conditions alter cases." This qualification should always be mentioned by city electricians when they have the case of Rochester presented to them, as it always will be when the cry of danger is raised by the telephone company.

Having considered the engineering features of joint conduit occupation, I would like to say a few words regarding the economic features.

It is a fundamental rule of economics that the paralleling of railroads is an economic wrong, and it is just as true in regard to conduit duplication. It is further true that all revenue received by any semi-quasi public utility corporation is derived from the general public. Consequently, any increased cost of construction will call for increased revenue, which has ultimately to be paid by the public. No one will deny that several conduit systems will cost considerably more than an equivalent capacity in one conduit system.

Joint use of conduits is equivalent to saying that there shall be only one conduit system, and that laid out at one time. The advantages are these:

Decreased cost of construction, and, therefore, more general adoption of conduit. Owing to less cost of construction, subsidiary underground distribution can be made, instead of the present overhead distributing system. Decreased cost of operation. Economy of the subsurface requirements of our public streets, which are fast being monopolized. Prevention of the repeated digging up of our streets.

In concluding my paper, I would say that regarding the ownership of such conduits, I believe in the conclusion reached by the two electrical commissions appointed by Washington, D. C., and Baltimore, that the ownership should be by the public. A commission appointed by the Massachusetts Legislature in 1897 to report on the street railway problem came to this important conclusion: "The ultimate full control of the street and exclusive ownership, whatever may be the part of its surface, by the municipality is, it may be said, now accepted in European countries as a fundamental principle of policy."

We see, therefore, that conduits as a public utility of a permanent nature of construction, requiring no operating department for their maintenance, are, therefore, especially adapted for municipal ownership.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.

The ninth annual convention of this society was held at Rochester, N. Y., Oct. 7, 8 and 9, in the rooms of the Chamber of Commerce. The first session opened with addresses of welcome by Mayor A. J. Rodenbeck and by Secretary Ives of the Chamber of Commerce, responded to by Col. G. M. Ballard, Vice-President of the Society, after which came the address of the President of the Society, Mr. Edwin A. Fisher, City Engineer of Rochester. Mr. Fisher attributed much of the successful development of the railway systems of the United States to the societies or associations formed by engineers engaged in railway work. He pointed out that the municipal officers of American cities control expenditures exceeding those of any one private industry, excepting only that of steam railways. The expenditures of 212 American cities for the year 1898 were estimated by N. P. Lewis, ex-president of this society, as follows:

Improvement of streets	$50,000,000
Water supply	35,000,000
Sewerage	14,000,000
Public lighting and public buildings	27,000,000
Parks and bridges	22,000,000
Total	$146,000,000

Mr. Charles Carroll Brown, M. Am. Soc. C. E., read the report of the Committee on Municipal Data and Statistics, which recommended the adoption, with slight changes, of schedules for uniform street and sewer statistics, submitted to the society in previous years, and also the adoption of the water-works schedule of the New England Water-Works Association. Both recommendations were adopted and the committee was directed to collect municipal statistics.

Mr. Wm. C. Crandall, Editor "Municipal Journal and Engineer," made a brief address on "Municipal Franchises," in which he said that he had sent inquiries to the mayors of 135 cities of 30,000 or more population, asking what income the cities received from the sale of franchises or taxes thereon. He received replies from 53 cities, and in many cases the replies were read in full. He said that the system of assessing public service corporations by local assessors often leads to injustice, and the system of uniform assessment by state assessors is receiving preference.

MUNICIPAL ENGINEERING IN ROCHESTER.

At the evening session the first of a series of five papers descriptive of Rochester was read by Mr. John F. Skinner, Special Assistant Engineer to the City Engineer. His subject was "Lakes, Conduits and Reservoirs," and stereopticon pictures were used in illustration.

A paper on "Water Supply and Electric Conduits" was next read by Mr. W. N. Radenhurst, Assistant Engineer in the Rochester water-works department. (For description of Hemlock Lake conduit see Engineering News, Apr. 11, 1895.) Mr. W. J. Stewart, First Assistant City Engineer, read a paper on "Sewers and Pavements," in which it was stated that Rochester has 75 miles of stone sewer, 8.5 miles of brick, 131.5 miles of pipe and ½-mile of wood and iron sewers. Up to 1859 all sewers were built of stone, when for the first time pipe was used. Now sewers of all sizes over 24 ins. diameter are of brick. All pipe sewers are now laid in Portland concrete, which prevents the penetration of the joints by roots that often completely fill a pipe.

The following was the mileage of different pavements in Rochester Jan. 1, 1902:

Medina stone block	9.17
Common Medina stone pavement	21.70
Asphalt	46.00
Brick	7.33
Macadam and telford	25.25
Gravel	15.25
Cobblestone	1.00
Wood block, cedar	0.71

The first brick pavement was laid in 1890 and the first asphalt in 1885. The asphalt pavement comprises:

	Miles.
Trinidad	27.0
Sicilian and German rock	11.0
Vulcanite	6.8
Asphalt block	1.0

The Vulcanite is no longer laid. The first general repairs to asphalt pavements were made in 1897 at a cost of 4.2 cts. per sq. yd.

The cost since that time has been:

In 1898	1.87	cts.	per	sq.	yd.
" 1899	1.67	"	"	"	"
" 1900	2.00	"	"	"	"
" 1901	3.00	"	"	"	"
" 1902 (estimated)	4.50	"	"	"	"

Mr. R. E. Danforth, Assistant General Manager of the Rochester Railway Co., read a brief paper on "Rochester Street Railways." The standard street car motor is 38 HP., and each 38-ft. car is equipped with four motors. There are 24 miles of track, of which a large mileage has been electrically welded during the past two years. In a welded joint two steel splice bars, 1×3 ins. $\times$ 18 to 30 ins. long, are used; and 30,000 amperes of current is passed through the abutting ends of the rail for 3 sq. ins. of cross-section. A 30-ton pressure is then applied. The total time required is 12 mins. The surface of the joint is smoothed with an emery wheel. The breakage of such joints in winter has been less than 1%. Where Medina block pavements exists, a 9-in. Trilby girder rail, 107 lbs. per yd., is used; where the pavement is asphalt, macadam or brick, a 7-in. 91-lb. rail is used. Mr. Danforth favors a T-rail on all streets except where the traffic is heavy, for in a grooved rail the formation of ice in winter causes serious delays to traffic. Asphalt should never be laid next to a rail, for the variations in heat expansion cause a separation of the rail from the asphalt; and water penetrates the joint so formed, causing disintegration of the asphalt. Toothing of stone or brick blocks is little if any better, but a strip of stone or brick block, two feet wide on each side of a rail, will protect the asphalt effectually. There have been used five types of foundations:

1. Concrete beams without ties.
2. Concrete beams with steel ties, 6 ft. c. to c., with 17-ft. connecting ties, 18 ft. c. to c., the whole bedded in concrete.
3. Concrete beams under rails and under wood ties, 5 ft. c. to c.
4. Solid concrete, 6 to 8 ins. deep, under wood ties, 2.5 ft. c. to c., with concrete between ties and under the base of the rail.
5. Wood ties, 2.5 ft. c. to c., on crushed stone, with concrete between ties and under base of rail.

[See Engineering News, Jan. 5, 1899, and Jan. 30, 1902.]

Of these five types, type (3) is now most favored because of its lower first cost and ease of construction. It is particularly to be recommended where alternate ties are gravel-tamped under their centers so that the track can be laid and lined up thereon, after which the 8×16-in. concrete beams are put in under the rails, and concrete is tamped under the centers of the ties not gravel-tamped.

Mr. J. E. Putnam, electrical engineer, spoke on "Examples of Improved Electrical Conditions in Track Returns," describing electrolytic action and damage to iron pipes which he said has been largely done away with by the use of welded rail joints and heavier rails reducing the resistance of the return circuit. A further description of the welding process was given.

PARKS AND PLAYGROUNDS.

Mr. G. A. Parker, Superintendent of Parks, Hartford, Conn., read the report of the Committee on Parks. A brief abstract follows:

One-twentieth of a city's area should be reserved for parks and squares. A playground should be allowed at least 300 ft. square to every square mile, and in densely populated sections more than one. Four other small squares should be allowed to the mile, of at least half an acre each. A thousand acres would then be divided as follows:

Playgrounds and squares	10	acres
Large parks	40	"
Streets and alleys	100	"
School grounds, etc.	5	"
Public purposes	155	"
Private purposes	850	"
Total	1,000	"

Does 15.5% seem a large proportion of area to give up to public uses? One-third of the cities already exceed that amount, and it is probable that if 20% is devoted to public use it will go far toward preventing crowding, and make the remaining acreage more valuable. A new profession is fast opening; that of architecture of cities.

At the close of this address, resolutions on the death of Mr. George A. Hotchkin, Superintendent of the Rochester Water-Works, were read and adopted.

MUNICIPAL SANITATION.

At the morning session of the second day, Prof. A. P. Folwell read the report of the Committee on Sewerage and Sanitation, the subject of the report being "Municipal Sanitation." Prof. Folwell emphasized the importance of statistics as a means of leading to the discovery of causes of disease, and recommended that the Board of Health of every city keep a record of every disease and its location on the city map. He pointed out that while in most cities the percentage of typhoid fever patients who died was but 10%, in Rochester it had averaged 25%, indicating probably a failure to report all cases to the health authorities. Speaking of the "smoke nuisance" he stated that unless public opinion has been formed by proper educational literature it is useless to enact ordinances for the abatement of the smoke nuisance. Since in the very densest of smoke only 0.7% is unburned carbon, it is useless to appeal to the pocket-book of the coal user. Smoke shuts out sunlight, the great germicide, and if for no other reason is objectionable. Consumption may be expected to increase where sunlight is excluded from the streets by high buildings and clouds of smoke. Speaking of food inspection, he said that there remains much to be done to reduce the death rate among infants and invalids who use "embalmed milks" and other foods preserved by formaldehyde and the like. New Orleans has three times as many food inspectors as has Philadelphia, with a fourfold population.

Cremation instead of the "potters field" was advocated. In New York State a square mile is required for burial purposes every 12 years. In the United States there are 26 crematories, and 13,000 bodies have been cremated in the last 25 years. Even now, however, not more than 0.1% of the dead are cremated.

In 1900, 36 cities of the United States had public baths, and in New York State every city over 50,000 is compelled by law to provide public baths.

Attention was called to the necessity of drainage in cities in order to destroy the breeding places of the mosquitoes that carry malaria and fever germs; and it was stated that wherever a large amount of trenching for sewers, water-works, etc., is under way malaria becomes prevalent.

A paper on "Residential Septic Tanks," by Burton J. Ashley, was to have followed, but owing to the absence of the author it was not read, but will be published in the proceedings of the society; and the same action was taken with a paper entitled "Practical Operation of Sewage Purification Plants," by John W. Alvord.

"The Biological System of Sewage Disposal," by John N. McClintock, was the title of the next paper read. The writer stated that he had recently visited a small residential plant installed by him a year previous, and on lifting the iron cover of the septic tank, detected no odor nor any solid matter, and the effluent from the secondary filter bed was as clear as from a mountain spring. Laborers on the premises drink this effluent water.

A manhole or sludge filter should be provided for cleaning out sludge. Septic tanks should be built in pairs. The fluid from the septic tank passes to the primary filter bed, 3 to 15 ft., ordinarily 5 ft. deep. This filter bed ordinarily contains gravel or coarse broken stone up to 1½ ins. diameter, although clinker, coke, or the like may be used. There should be 1 cu. yd. of broken stone per capita of population served. The secondary filter beds are about the same depth as the primary beds, but have 1½ to 2 times as much capacity, and contain sand or fine gravel.

The sewage of a city may be thus treated on an acre of ground for every 10,000 inhabitants; and this acre may be entirely covered over and used as a park, or it may even be used for street purposes where existing pipe lines offer no obstacles.

Mr. John H. Emigh, City Engineer of North Adams, Mass., read a paper on "Sewer Maintenance," in which he urged that a systematic record of cost of cleaning sewers and manholes be kept. An inspector should first be sent out to sound the depth of deposit in manholes, so that no time will be lost by the laborers in removing deposits that are very shallow. Where this method was followed and a record kept of every item, it was found that in 1899 the cost of removing, loading and hauling (2,000 ft.) a cubic yard of such manhole deposit was 66½ cts., and in 1900, 68 cts. Mr. Emigh did not favor tapping a sewer pipe on the side for a lateral, as the joint so made usually causes interference with the flow, but favored tapping it from above, using an elbow, the whole embedded in concrete.

In the discussion that followed the fact was brought out that manufacturers have recently provided two means of overcoming the objection to lateral tapping. One method is to use a pipe provided with a shoulder that prevents its being inserted too far into the main sewer pipe when tapped; the other, and apparently better device, is a split Y; that is, a Y split horizontally into two sections, and provided with flanges. Where it is desirable to have the lateral enter, a length of pipe is broken out, and in its place is first inserted the lower half of the split Y, on top of which is laid the upper half, and the lateral flanges of the two halves are cemented together.

The report of the Committee on Disposition of Garbage and Street Cleaning consisted largely in reading a paper written by Mr. Ernest Adam, of Newark, N. J., in which was given a table of the methods of garbage disposal used by 135 cities of the United States, the data having been gathered from the annual reports of various city officials, and from the columns of Engineering News.

STREET LIGHTING.

At the opening of the morning session of the third day, Mr. Charles H. Rust, City Engineer of Toronto, read the report of the Committee on Electric Street Lighting. In the discussion that followed, Mr. Fisher gave some interesting data relative to the cost of lighting in Rochester, and exhibited the new specifications, which are very complete. There was also shown a "luminometer," such as was described in a paper on the "Relative Merits of Open and Enclosed Arc Lights," by W. D'A. Ryan, read before the Ohio Electric Light Association, Aug. 20-22, 1901. By means of the "luminometer" the relative candle power of lights is quickly ascertained.

WATER SUPPLY.

In the report of the Committee on Water-Works, it was stated that the time is ripe for improving the smoothness of the interior of cast-iron pipes by glazing or otherwise.

Mr. Geo. W. Rafter then read a paper on "State Water Supply in New York," advocating state ownership of the water sheds and reservoirs. He said that there are now 60 stations in the state where rainfall is daily recorded, but there should be 30 more in the mountains. There are 50 stations where streams are gaged, and stream gaging he considered more essential even than rainfall recording.

STREET PAVING AND HIGHWAY IMPROVEMENTS.

In the report of the Committee on Street Paving read by Mr. Nelson P. Lewis Chief Engineer Board of Estimate and Apportionment, New York city, the interesting fact was brought out that there are 82,000,000 sq. yds. of macadam in 140 cities of the United States, a statement that should have some weight with those who have not favored macadam as a pavement for residential streets.

"Work of the New York Highway Commission" was outlined by Hon. Edward A. Bond, State Engineer and Surveyor. He said that New York State, with an area of 50,000 sq. miles, has some 75,600 miles of public highways, and of this about 10% might be considered main highways that it will be the duty of the state to pave at an estimated cost of $60,000,000. Already since the passage of the now celebrated Higbie-Armstrong law, under which the state bears half the expense of road improvement, there have been built 120 roads, or a total of 355 miles, at a cost of $2,930,000; and the Town Supervisors have voted to build 214 miles more up to the present time. The three states, aside from New York, that have done the

most improved road building, with their respective paved mileage, are:

New Jersey	642
Massachusetts	480
Connecticut	108
Total	1,230

The assessed valuation of real and personal property in these three states is 5½ billions of dollars, while that of New York is 8½ billions. Mr. Bond concluded by saying that it would probably not be a long time before the $5,000,000 of annual excise revenue in New York would be used in building improved highways, but even by using this amount it will be 12 years before the main highways are paved.

In the discussion that followed he stated that the roads so far built radiate like the spokes of a wheel from the cities as hubs. Mr. Bond believes this arrangement to be the best for all interests, and does not think the time ripe for building trans-state or trans-continental paved highways.

The "Work of the Massachusetts Highway Commission," by Hon. W. E. McClintock, Chairman of the Commission, was given in detail. Mr. McClintock gave credit for the passage in 1893 of the present "good roads law" to the bicyclists. In 1894, the first appropriation was made, and up to date $4,400,000 have been expended in macadamizing and graveling. With an area of 8,000 sq. miles, Massachusetts has 20,000 miles of roads. The counties bear 25% of the cost of road improvement; the state, 75%. Half of the road contracts have been let to the Selectmen of the Towns, more for the purpose of educating road builders than with an eye to economy. In addition to the 480 miles of paved roads built under state supervision, the Selectmen have built 500 miles, making a grand total of 980 miles of paved roads in Massachusetts. Mr. McClintock said he was not ashamed to say that the roads have been costly, but maintained that the Commission was willing to pay whatever it might cost to get just what was wanted. He said that the shorter hours of the labor day (9 hrs.), and greater cost of team and labor wages in Massachusetts made the work 30% more expensive than in New Jersey to begin with, and the building of roads in short sections added further to the cost. He did not make it clear, however, why the average cost of a mile of standard macadam in New Jersey has been less than half what it has been in Massachusetts. Including gravel roads, the average cost of all roads in Massachusetts has been $8,200. The cost of maintenance has thus far been $100 a mile per year. [It should be observed, however, that more than half the macadam has been down less than 4 years, and has consequently required very little repair as yet.—Ed.]

Mr. McClintock said that he believed in the foreign method of continuous repairs, and that it is the method now in use in Massachusetts. Speaking of telford bottoming, he said that he has entirely abandoned its use, and where the soil is so treacherous as to require a sub-foundation for the macadam, 9 ins. of gravel is used with results equally as good as a telford bottoming. The gravel bottoming costs only one-fifth to one-half as much as telfording. Mr. McClintock believes in Macadam's theory that the telfording acts as an anvil upon which the broken stone wearing coat is pounded to pieces. [The existence of some 20 miles of telford pavement in Rochester, where no such action has been observed, may be cited in opposition to this theory.—Ed.]

In answer to a question as to the effect of sprinkling macadam with oil, Mr. McClintock replied that the experiment had been tried upon a short section of road exposed to high winds, which swept off dust or sand from the road, leaving it subject to raveling. Crude petroleum was sprinkled over the road. It was not warmed, as in California experiments on earth roads, nor did it contain the 30% asphaltum of California oils. Three months later very little of the oil was to be found, and a year later, none at all. The oil appeared to have acted as a lubricant on the stones, for they were easily displaced, and the road was badly cut up; moreover, it damaged the clothes of bicyclists and the varnish of vehicles, leading to many complaints. [See Engineering News, Oct. 9, 1902, p. 281, for data relative to use of crude coal tar on macadam in Switzerland.]

Mr. Geo. W. Tillson gave the following data relative to the cost of resurfacing macadam in Brooklyn by day labor: Labor, $2.00 for 8 hrs.; steam roller, $10 for 8 hrs.; and trap rock delivered on street, $1.52 per ton. A 4-in. trap rock macadam laid directly upon an old macadam surface cost 35 cts. a sq. yd.; while a 6-in. macadam laid upon a surface that had been picked up with the spikes of the roller cost 58 cts. a sq. yd.

Mr. McClintock said this cost confirmed his rule for cost of resurfacing, which is 10 cts. a sq. yd. for each inch of macadam.

"Cost of Pavements and Roads in Small Towns" was very briefly treated by Mr. Emmet J. Steece, City Engineer, Burlington, Iowa. Mr. Steece gave the following data of cost, but did not state who was the authority for the same. With labor at 15 cts. per hr. the cost of macadam is:

Hand drilling	$0.22
Labor	0.20
Explosives	0.03
Loading and hoisting	0.05
Feeding crusher	0.04
Engineer and helper	0.04
Repairs	0.03
Fuel, etc.	0.05
Total	0.66
Hauling one mile	0.35
Spreading	0.09
Rolling	0.17
Grand total	$1.27

[This was given as the cost of macadam in place. It seems to us, however, a low estimate of the cost of the loose stone; and it requires 1½ to 1⅔ cu. yds. of loose stone and screenings to make 1 cu. yd. of rolled macadam. Moreover, several items have been omitted, as, for example, sprinkling.—Ed.]

The cost of laying brick in cts. per sq. yd. was given by Mr. Steece as follows:

Spreading sand	0.5	Tamping	0.5
Wheeling brick	2.0	Patching	0.5
Laying	1.5		
		Total	5.0

Mr. J. W. Howard read a paper on "Pavements Injured by Water; How to Minimize the Injury," in which it was stated that two-thirds of the city streets in the United States are still unpaved. A very interesting table was contained in the paper giving a traffic census of many European and American streets. The following data relative to American cities was compiled by Mr. Howard, and is here given only to the nearest one hundred teams that passed both ways from 6 a. m. to 6 p. m.:

Broadway, New York city	7,800
Fifth Ave. " " "	5,500
Madison Ave " " "	2,400
Chambers St., " "	2,300
Clark St., Chicago	4,400
Locust St., St. Louis	3,200
Fifteenth St., Washington	4,500
Main St., Buffalo	2,600

Many other streets, together with their respective widths, were given in the table; but such as are here enumerated show strikingly how small is the traffic on American streets compared with those of London and Paris.*

Mr. Howard said that the asphalted streets of Buffalo are in a very wavy condition, and attributed much of this to the disintegrating effect of water on the concrete foundations.

It may be said with greater reason, we think, that the concrete, where found to be soft, was, as a matter of fact, lean in cement when first laid by the contractors; furthermore, that 6 ins. of concrete on a clay soil like that of Buffalo is insufficient to uphold heavy traffic without a gravel sub-foundation between the clay and the concrete.

"A Year's Experience in Laying Bituminous Macadam" was the title of a paper by Mr. Fred. J. Warren, in which it was stated that his company has contracts for 630,000 sq. yds. of bituminous macadam in 39 cities of the United States, to be laid this year. In 18 cities this work is now in progress. There is now invested in the business some $750,000, and 20 complete paving plants are owned by the company. Samples of the bituminous macadam were shown, from which it appeared that the tar formed the binding element, not only of the wearing coat, but of the base or foundation. When asked whether an ordinary macadam base bound with screenings and provided with a 2 or 3-in. wearing coat of stone bound with tar or asphalt had ever been laid, Mr. Warren said that it had not. He further stated that the actual cost of the bituminous macadam 6 ins. thick as now made is as great as asphalt on a 6-in. concrete foundation.

In Pawtucket, R. I., a bituminous macadam pavement has been laid on a 12% grade and has given an excellent foothold for horses, while it is not cut up by surface water as ordinary macadam would be on such a grade. In the discussion that followed, Mr. McClintock vouched for this statement, saying that he believed bituminous macadam to be the best of all pavements for steep grades, and cheap at any price. [For further information on bituminous macadam, see Engineering News, Jan. 30, 1902.]

The last paper read was by Mr. F. A. Kummer, on "The Use of Wood Pavement Under Heavy Traffic." The New York company with which Mr. Kummer is associated makes wood paving blocks of Georgia pine treated with 10 lbs. of creosote per cu. ft. and 10 lbs. of rosin, the latter preventing absorption of water with consequent swelling. The blocks are sawed and laid with close joints. For heavy traffic the joints are filled with sand only, and the traffic soon pounds the wood together, completely closing the joint. 60,000 the traffic is light the joints are pitch-filled. 60,000 sq. yds. have been laid by Mr. Kummer's company; and the ordinary price with a 5-year guarantee for 4-in. blocks on 6 ins. of concrete is about $3.25 per yd. A block that had been laid two years ago on Tremont St., Boston, was shown. It had been compressed and worn only ⅛-in. in that time. A life equal to the effective life of granite block is claimed for this pavement under heavy traffic, and it is comparatively noiseless. A stretch of this pavement in front of the Auditorium Hotel, Chicago, is now in its fourth year, and is perfectly smooth and wearing excellently.

In the general discussion that followed the reading of the last paper on pavements, Mr. McClintock was asked by Mr. H. P. Gillette what precautions if any were used to keep the subdrains and ditches of Massachusetts roads open in the spring of the year, to which it was replied that no precautions were taken. Mr. Gillette then said that especially in cuts and over clay subsoils such precautions would far more than repay their cost, for the snow dams up the drains and ditches, and as it melts the water follows the line of juncture of macadam and subsoil, penetrating the latter so that if it is clayey, no matter how deep or how many the sub-drains, the clay will become more or less saturated and yield under traffic unless a gravel sub-foundation is provided.

Mr. McClintock said that even moist clay would support 3 to 4 lbs. load per sq. in., and that the pavement should be designed to distribute the concentrated wheel load so as to bring the pressure within that limit. He did not, however, give any rule by which the pressure per sq. in. on the subsoil due to any given wheel load might be ascertained for different depths of pavements, and it is not saying too much to remark that such a rule, based upon experiments, would do much to make road building a science where now it is an art.

Mr. Lewis, speaking of the guarantee period of asphalt pavements, said that up to the time when the Greater New York was created, it had been 15 yrs. in New York and 5 yrs. in Brooklyn, since which time it had been 10 yrs. in Greater New York. He, however, himself favored 5 yrs., saying that he believed that the further asphalting of streets would divert much of the traffic now concentrated on asphalted streets, while the increasing use of rubber tires and rubber pads on horses' hoofs is materially lessening wear. Moreover, no one can safely predict how soon the horse will have largely disappeared from New York streets; and it seemed to him not unlikely that within a decade automobiles will have driven most

*It is doubtful, however, if statistics of the number of vehicles alone give an accurate measure of the relative traffic of foreign and American cities, on account of the large proportion of light one-horse cabs in foreign cities, and the large proportion of heavy trucks in American cities.—Ed.

of the horses out of use in cities. In view of all these conditions he believed it to be in the interest of true economy for the city to require a short guarantee period.

The officers of the society elected for the ensuing year are: President, Charles H. Rust, Toronto, Canada; first vice-president, G. M. Ballard, Newark, N. J.; second vice-president, Prof. A. P. Folwell, Easton, Pa.; third vice-president, Edward D. Lagsdin, Indianapolis; secretary, George W. Tillson, Brooklyn; treasurer, F. J. O'Brien, Oswego; members of the Finance Committee, Emmet J. Steece, Frederick Giddings and J. M. McCartin.

A banquet was held at Teall's Hall on the evening of Oct. 8, at which there were speeches and toasts by officers of the Association, the Mayor of Rochester and others. Tallyho rides to points of interest in the city were taken, also to the various state roads in process of building, of which there are 48 miles in Monroe county. The attendance at the meeting was better than in the past, averaging about 65 at each meeting. Indianapolis was selected as the place for the next convention.

HIGHWAY BRIDGE OF 465 FT. SPAN OVER THE MIAMI RIVER, AT NEW BALTIMORE, O.

One of the longest, if not indeed the longest, highway bridge span in this country, is that built over the Miami River at New Baltimore, O., having a span of 465 ft. c. to c. of end pins. This bridge was completed on Dec. 1, 1901, and opened for traffic Dec. 15, 1901. In our issue of May 23, 1901, we illustrated and described a bridge of 406 ft. span over the same river at Columbia, O., and alluded to the fact that highway bridges with spans of over 400 ft. are sufficiently unusual to warrant some particular attention.

The New Baltimore bridge is a pin-connected structure, with two through trusses, 465 ft. long, divided into 17 panels, and with a depth of 66 ft. 6 ins. at the middle, as shown in Fig. 1. These trusses are spaced 27 ft. 4 ins. apart c. to c., or 25 ft. in the clear. The top chord has an almost uniform curve from the end posts, which gives it a very good appearance, but in the three middle panels it is horizontal. The bridge is designed for a live load of 2,600 lbs. per lin. ft., with a live load of 100 lbs. per sq. ft. on the floor system, and a 6-ton road roller as a concentrated load. The material used is medium steel, conforming to the Manufacturers' Standard Specifications. The weight of the structure is about 500 tons.

The top chords and end posts are of trough section, with two 23½-in. web plates and a 28-in. cover plate with top flange angles 4 × 4 ins., and bottom flange angles 4 × 6 ins., the latter being connected by lacing bars. The bottom chords are composed of 6-in. eyebars, two 1 9-16-in. bars in each of the two end panels, and four bars 1 3-16 ins. to 1 9-16 ins. thick in all the others. The pins in the top chord are 4 7-16 ins. diameter, and those in the bottom chord 5 7-16 ins., while the end and hip-joint pins are 5 15-16 ins. diameter. The pins for the top lateral bracing are 1 5-16 ins. diameter. The posts are composed of pairs of channels, set back to back, and connected by lattice bars in a plane transverse to the axis of the bridge. The diagonal web members are eyebars and loop-end rods, the latter being made adjustable by means of turnbuckles. At the intersections of these web members are 4 7-16-in. pins. In three alternate panels on each side of the center panel, there are longitudinal struts, each composed of a pair of 8-in. channels with top and bottom lacing.

The floor system, shown in Fig. 2, consists of 38-in. plate girder floor beams riveted between the posts, and carrying nine lines of 12-in. I-beams, 2 ft. 4 ins. and 3 ft. c. to c. The floor is of 2½-in. oak plank, on five oak nailing joists, 4 × 10 ins., to each panel. Guard timbers 6 × 6 ins. are laid at the side of the roadway, against the posts. There is no sidewalk, and no street railway track. The expansion bearings at the moving ends of the bridge consist of two nests of 12 rollers 2 7-16 ins. diameter and 2 ft. 11⅛ ins. long, under each end post.

The portals are 8 ft. deep, composed of three horizontal struts of double angles 3 × 4 ins., and diagonals of single angles 1½ × 2½ ins., all connected to 5-16-in. side plates 26½ ins. wide, riveted to the cover plates of the end posts. The top lateral bracing consists of box latticed struts at panel points, built up of four angles, with lacing bars for web members. There are diagonal rods in each panel except that in the panel next to the portals the diagonals are of similar construction to the struts, with plates at the intersection. Transverse box latticed struts are also placed between 12 pairs of the truss posts, where the height is sufficient to admit of their use. A pair of transverse diagonal rods are fitted as sway bracing in the panels between the upper and lower struts, as shown in the cross-section, Fig. 2. The clear headway allowed is 16 ft. 6 ins.

The bottom lateral system consists of diagonal rods in each horizontal panel, the rods being attached to vertical pins held by pairs of angle brackets riveted to the webs of the plate girder floor beams. There are four rods in each panel, one pair near the top and the other near the bottom of the floor beams. A box lattice strut is fitted between the feet of the end posts. The top lateral system is designed for a load of 150 lbs. per ft., and the bottom lateral system for a load of 400 lbs. per ft.

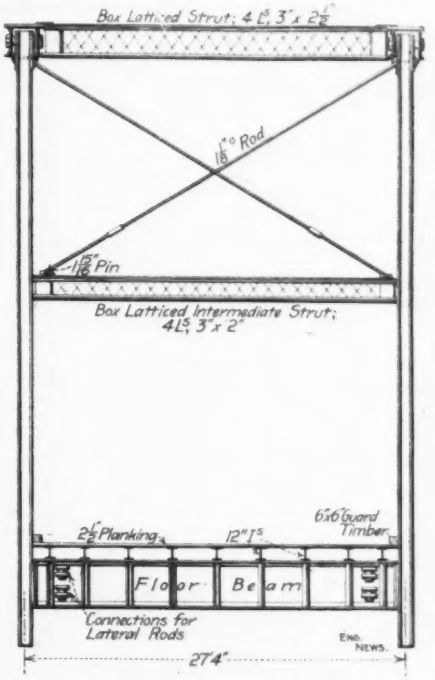


Fig. 2. Cross-Section of 465-Ft. Highway Bridge.

The substructure is of dimension stone quarried at Reardon, O., the foundations being of concrete. The approaches are paved with 12 ins. of broken stone covered with 3 ins. of gravel. The contract for the masonry substructure work was let to Wellman & Sons, of Cincinnati, O. The superstructure was built by the Brackett Bridge Co., of Cincinnati and was designed by Mr. J. H. Hilton, who was at that time Chief Engineer of the company. The bridge was built for the County Commissioners of Hamilton county, under the direction of Mr. Frank S. Krug, County Engineer, of Cincinnati.

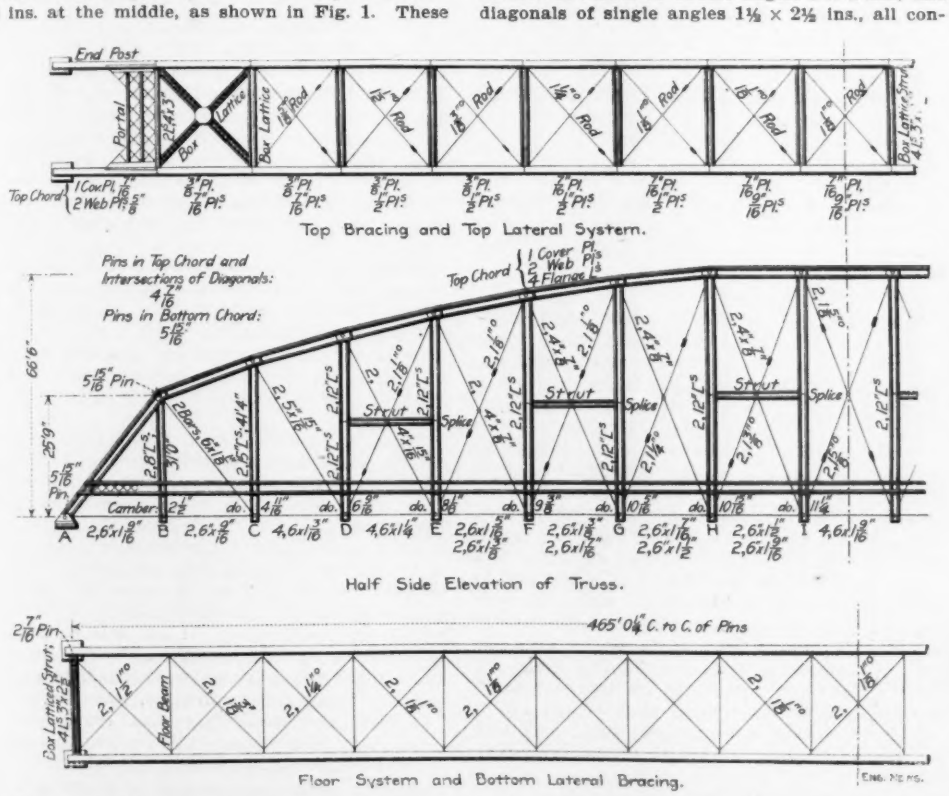


FIG. 1. ELEVATION AND PLAN OF HIGHWAY BRIDGE OF 465-FT. SPAN OVER THE MIAMI RIVER AT NEW BALTIMORE, O.

Brackett Bridge Co., Cincinnati, O., Designers and Builders; F. S. Krug, County Engineer of Hamilton County.

THE CHANGE IN CONDITIONS in the United States by decennial intervals from 1800 to 1850 and annually from 1850 to 1902 forms the last monograph issued by the U. S. Bureau of Statistics, under the title of "Progress of the United States in Its Material Industries." This progress is shown in a series of tables relating to area, population, wealth, debt, money in circulation, banks, farms and values, manufactures and value, imports, exports, railways, shipping, etc. In the interval 1800-1902 the area of the country—exclusive of Alaska and island property—has grown from 827,844 to 3,025,600 sq. miles; the population per sq. mile from 3.6 in 1810 to 26.1 in 1902; the total wealth from 7 billion dollars in 1850 to an estimated 94 billions in 1900; the per capita wealth from $307 in 1850 to $1,235 in 1900. The public debt per capita shows great fluctuations. In 1800 it was $15 per capita; in 1840, 21 cts. per capita; in 1852, $2.67; in 1861, $2.74; in 1865, $76.98; in 1880, $38.27; in 1890, $14.22; in 1893, $12.64; 1902, $12.97 per capita. Money in circulation amounted to $13.85 per capita in 1860; $20.57 in paper currency during the Civil War; 1892, $24.60; 1900, $26.93; 1902, $28.40, the highest point ever reached. Farm values have increased from 4 billions in 1850 to 20 billions in 1900; and the value of farm products from $1,958,000,000 in 1870 to $3,764,000,000 in 1900. The value of the product of manufacturing industries grew from 1 billion in 1850 to 13 billions in 1900.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, } ASSOCIATE EDITORS.

A. B. GILBERT, - - - - - - - ASSISTANT MANAGER.

CHAS. W. REINHARDT, - - - - CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. E. READ, Boston, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE. 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.00 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current Volume, 15 cents.

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 323 means that subscription is paid to the 32d week (that is the issue of Aug. 6) of the year 1903; the change of these figures is the only receipt, unless one is sent by special request.

ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

"Sweet are the uses of adversity." The coal strike of 1902 may yet be worth all it costs in loss and suffering if it brings before the people of the United States the absolute necessity of facing the economic evils that now threaten our social order, and taking prompt and effective action toward their remedy. A great object lesson is being taught. It is seen more clearly than ever before that the rights of the public are the paramount rights. The coal-mine owners' right of private property and the coal-mine workers' right to refrain from working must both yield to the people's right to have coal furnished to them. If mine owners and mine workers refuse to supply the necessities of the public, then somewhere and somehow power must and will be found to compel them to stand aside and let others take their place who will do the work.

As was said at another time, it is a condition, not a theory, that confronts us. Politicians may theorize as they please concerning the impossibility of dealing with the trust problem or the labor problem; but a million empty coal bins are a silent witness to the falsity of such theories. A civilized nation with an organized system of government need not and will not sit passive and permit any combination of labor or capital to deprive it of a necessary of life. Every system of Government has the power to cope with such an emergency beyond the letter of any constitution or statute. "Necessity knows no law" is as true of organized society as of anarchy.

Let it not be thought, however, that we are pleading for radical action. Rather we plead for such conservative action as shall make radical action unnecessary. The widespread public demand for Government ownership of coal mines and railways would never have arisen if Government had possessed and exercised powers for the control of monopolies.

The most dangerous man in organized society is not the extremist, who is clamoring for Government ownership of coal mines or railways. It is the ultra-conservative who refuses to recognize the rapid changes that the years have brought and who fights every attempt to bring the great capitalistic monopolies of the present day under wholesome restriction. It is men of this latter class who are doing most to bring about the "state socialism" which they so much decry. They would dam up the rising torrent until the barriers break in a devastating flood, instead of drawing off the waters into safe channels.

We have said above that Society has the power to protect itself against monopoly. Let us make this point clear. It is often reiterated that Society must not interfere with the right of private property or with the freedom of the workingman to work or not as he pleases. But Society has a right to draw a distinction between the property of a private individual and the property of a corporation. When the entire machinery of an industry is brought under a single control, that industry is no longer private property. Its duties and obligations to the public transcend its obligations to the holders of its stock and bonds. This is, indeed, already well recognized in the case of certain monopolies. A railway company must operate its trains, for example, and perform its duties to the public, even though no profit is earned for the stockholders. So, too, with a labor monopoly. A labor organization which undertakes to control the working force of an entire industry makes itself a necessary servant of the public, and assumes responsibilities which it must not be permitted to evade.

It is proper that emphasis should be laid on this subject in these columns, for these modern economic problems fall especially within the province of the engineer. President Pritchett called attention to this in his address to the entering class at the Massachusetts Institute of Technology the other day. As a forceful illustration comes now the offer of the anthracite coal operators to submit their differences with their employees to the arbitration of a commission of five, of which two are specified to be engineers. We doubt whether there has ever been a more striking example of public confidence in the ability and impartiality of the engineering profession.

The paper on signaling for urban and interurban railways, read at the meeting of the Street Railway Association at Detroit last week and printed on another page of this issue, ought to be heeded by managers of high-speed electric railways. The record of accidents on such roads is reaching appalling proportions, and there is no denying the fact that a large proportion of these accidents are due to operating at steam railway speeds without the safeguards which generations of experience in steam railway service has shown to be necessary. It is true that signaling and dispatching systems cost money to install and to maintain, but it is an expenditure which the electric railways will be compelled to make in fulfilment of their obligations to the public. In fact, self-interest is likely to bring this about, for there seems to be no limit to the size of damage awards; and in the present state of the art of railway operation, a company is sure to be held responsible for every death or injury caused by collisions.

A complete electric power distribution system in a newly-constructed steel plant in Belgium is described in an article on another page of this issue. The information given, we regret to say, is extremely meager, and we print it only because it gives news of an unusual and hitherto unprecedented application of electric motors, of which no fuller data are available.

Discerning readers will recognize in this lack of needed data a general fault that pervades published descriptions of electrical engineering work. It may be said, for the benefit of those not familiar with the condition of contemporary electrical engineering, that this deficiency is largely due to the fact that most of the published information concerning electrical installations comes from the manufacturer who supplied the machines and appliances, and is practically unobtainable from other sources. Unfortunately for technical literature, and those who have to use it, the manufacturer seems more particular that a published article should state that so many machines of such and such a power were bought of his company, than that it should give technical details or explain the general engineering problems involved.

In some part, however, the above-mentioned lack is to be charged to the electrical engineering profession generally. Other branches of the engineering profession are familiar with each other's work, and make due application of it and allowance therefor. The electrical branch of the profession, however, has throughout its development been but little in touch with the other branches, a condition which is correcting itself only in recent times. In consequence, when work in electrical engineering is described, one generally finds a failure to fully appreciate the relation of the electrical portion to the entire work, or at least to recognize that the electrical equipment has a farther interest as a constituent part of a whole.

There are, of course, many brilliant exceptions to the general statement that electrical engineering has grown up in isolation from other branches of the profession. An instance is the way in which the large American electrical manufacturers have developed the design of electrical appliances viewed as machines and not merely as apparatus. This is displayed in nothing better than in the way they mastered the art of designing in cast iron, and produced machines the lines of whose frames have been copied as standards all over the world.

The chief feature of interest in the Antwerp steel works installation is the direct driving of roll trains by electric motors. This service is so severe and so fluctuating that the electric motor seems ill suited for it. The speeds are low, hence the turning moment is high; large loads are suddenly applied and suddenly released, as the work enters and leaves the rolls, and the variations in the required torque are correspondingly large and abrupt. Such conditions are probably of particular importance when, as in the present case, induction motors are employed. It is said that the Antwerp plant is working successfully, but it must be borne in mind that the mills described are small, and apparently handle a very light class of work, possibly wire-rod or strips. Success in such a field, therefore, would not prove the applicability of the electric motor to heavy rolling-mill work.

Even with this light work, there is evidence that the engineers who designed the installation were hard put to it to work out a satisfactory installation. They coupled the electric motor direct to the roll-shaft of the finishing mill, notwithstanding the slow motor speed which this made necessary. On the blooming mill, however, speed reduction was an absolute necessity, so they connected the motor to the roll-shaft by a belt and added a 30-ton flywheel. It would be interesting to know the life of a belt working in the heat and dust of a rolling mill, exposed to radiation from glowing ingots, flying mill scale, water, etc.

It seems a pretty safe guess that the decision to drive these three rolling mills by electric motors rested more on the desire to fit this element of the plant into the general scheme of central-station electric distribution than upon any inherent advantages of the electric motor for driving a roll train.

Three butchers of Norfolk, Va., have just been indicted for conspiracy to defraud the U. S. Government in submitting bids for furnishing beef to the Navy Department. It is alleged that, under previous agreement between them, the bids were arranged beforehand, and the bidding officer was deceived by the fact that a number of bids at various prices were submitted.

The trial and decision of this case will be of

great interest; and it is a matter of congratulation that the Government has taken it up. Some judicial decisions on the question how far one may go in such negotiations without making himself subject to criminal prosecution, will be of great value.

The fact that bids at different prices were submitted by the different conspirators will go far to establish the Government's case, for the courts are likely to draw a distinction between the mere agreement not to compete and the attempt to deceive the Government's representative. For example, it might not be held criminal for A to pay B a hundred dollars not to put in a bid, and criminal for him to pay B the same amount to put in a bid lower than his own.

Of course, it is well known that in these days if every person who enters into a contract or agreement to restrict competition were put in prison, those of us left on the outside would feel lonesome. The predicament into which this wholesale suppression of competition is leading civilized society is being remarkably illustrated just now; and it is well to have the matter tested how far existing laws can protect that portion of the public which still has to have its earnings fixed by a competitive process.

Since "imitation is the sincerest flattery," we suppose we should be flattered over the action of two of our esteemed contemporaries in the municipal engineering field which have appropriated, without credit, our report of the annual convention of the New England Water-Works Association, published in our issue of Sept. 18.

Our report was prepared by a member of our editorial staff who attended the convention and prepared the report from notes taken during its sessions. Some three weeks after the convention he received from one of the journals above referred to a postal card advertising as a special feature of its October issue its report of the New England Water-Works Association meeting, and inviting him to remit 25 cts. for a copy of the number. On reading the report it appeared to him to have a strangely familiar sound, and a comparison made at once plain from what source the inspiration for the report was obtained. As an amusing contribution to the comparative study of editorial cribbing, we print in parallel columns a sample paragraph from our report and the corresponding paragraph from each of our contemporaries. It is curious, indeed, that in this brief abstract of a paper of considerable length, each of our esteemed contemporaries selected exactly the same points as our own editor, and treated them in almost identical language!

(*Engineering News*, Sept. 18.)

DUTIES OF MUNICAPALITIES REGARDING WATER SUPPLY.

Mr. J. O. Hall, of Quincy, Mass., spoke on this subject from the viewpoint of a mayor who has taken unusual interest in water supply matters. He believed water-works is one of the few public utilities which should be under municipal ownership. He did not favor restricting the use of water, except that he would discourage its use for driving water motors. Manufacturing services should be metered and fire hydrants should be under the charge of the fire departments. Uniformity of accounts among different cities, he thought, is well-nigh impossible. He did not favor putting all the cost of the public service on the various municipal departments, and he did favor making the charge for domestic service light.

(*Contemporary No.* 1.)

J. O. Hall, of Quincy, Mass., delivered an address on the "Duties of the Municipalities Regarding Water Supply." He said he believes the water-works is one of the few public utilities which should be under municipal ownership. He did not favor restricting the use of water, except that he would discourage its use for driving water motors. Manufacturing services should be metered and fire hydrants should be under the charge of the fire departments. He did not favor putting all the costs of the public service on the various municipal departments, and he did favor making the charge for domestic service light.

(*Contemporary No.* 2.)

A paper on the "Duties of Municipalities Regarding the Water Supply" was presented by Mr. J. O. Hall, of Quincy, Mass., who treated the subject from the standpoint of a mayor interested in water supply matters. Mr. Hall considers water-works one of the first public utilities to come under municipal ownership. He does not favor restricting the use of water except for running water motors. All manufacturing services should be metered and the fire departments should have charge of the hydrants. The uniform system of accounts for different cities he does not consider possible, nor does he favor placing all the cost of the public service on the various municipal departments. Charges for domestic service should be made light.

FEATURES OF THE AMERICAN STREET RAILWAY ASSOCIATION'S CONVENTION.

The development of the electric railway in the United States is well reflected by the American Street Railway Association's convention, held at Detroit last week.

This association is the outgrowth of a society of the same name, which in the old horse-car days used to discuss such topics as the best kinds of feed and the relative durability of horses and mules. The introduction of the electric motor has revolutionized the association, and its annual meeting now ranks in importance with that of the National Electric Light Association or the conventions of the Master Car Builders and Master Mechanics.

While it is still called the Street Railway Association, it has really outgrown this field and now covers the entire field of electric railway operation. A proposition has been made, informally, to change the name to the Electric Railway Association, and it is not unlikely that this change may eventually be made.

Whether this is done or not, however, some change is needed in the organization to give due representation to the interurban companies. The association is composed of companies, not individuals, and the constitution, as it now stands, limits the membership to "street railways"; and electric railways built on their own right of way are thus excluded. It is probable that steps will be taken to rectify this state of affairs.

Each member company can send a number of delegates from among its officers, and the Detroit meeting had an exceptionally large attendance. This was due in part, perhaps, to a resolution adopted by the executive committee and printed prominently in the announcement of the meeting, by which the executive officers of the different companies were requested

to notify all delegates and heads of departments attending the convention that they are expected to be present at all sessions of the meeting and to take part in the discussions.

One of the features of the convention was the preliminary organization of an association of street railway master mechanics, on lines similar to the American Railway Master Mechanics' Association. In regard to the title of the new association, it may be noted that the American Railway Master Mechanics' Association has long outgrown its name, and is now largely composed of men who are the superior officers of the master mechanics. The new street railway association will also probably be composed largely of higher officers than master mechanics, whatever may be their specific titles, and this should be borne in mind in selecting a name.

Undoubtedly the most notable feature of the convention was the presidential address of Mr. H. H. Vreeland, President of the Metropolitan Street Ry. Co., of New York city, in which he made a bitter attack on American municipalities for oppression and extortion of street railway companies. As Mr. Vreeland's audience was composed of the officers of street railway corporations, his remarks in this line were, of course, loudly applauded; but as a matter of fact his position is a most untenable one, and wholly unworthy of a man of Mr. Vreeland's ability and position.

Mr. Vreeland knows very well that the value of American street railway franchises to their holders is almost invariably far beyond the sums paid by these holders to the public treasury. He knows also as a matter of history the way in which these franchises were procured from the public authorities. He has much to say of the venality and corruption of public legislative bodies; but he fails to add that for much of that same venality and corruption the corporations themselves are responsible. The promoters of street railway corporations who chose to obtain franchises by corrupt deals with public officials instead of by honest contributions to the public treasury sowed the seed for the legislative "strikes" of which Mr. Vreeland now complains.

Again, Mr. Vreeland declares that the municipalities are placing burdens on the companies far greater than was agreed upon when the franchises were granted, and he insists that this is an infringement of their contracts. But he omits all reference as to how these so-called contracts were made. It is a sound principle of law that a contract tainted with fraud, or which infringes principles of equity or sound public policy ought not to be enforced. More than this: a contract entered into by one of the parties in ignorance should be subject to judicial relief.

It is slightly amusing, also, for Mr. Vreeland to say that he looks forward to the day when street railway stockholders will stand up for their rights as shareholders against the exactions of municipalities, and again where he declares that the heads of street railway corporations "conduct the business of these properties as a trust, and have nothing to do with the stock market." By the same token, we suppose Mr. Vreeland would claim that the recent exploits in "high finance" in which certain great street railway properties have figured were all conceived and carried out for the sole benefit of the dear stockholder.

When representatives of great public service corporations like Mr. Vreeland will consent that the light of publicity shall be turned on all the transactions of their corporations, and that the public shall have an equitable share in the profits of the enormously valuable monopoly privileges which these corporations enjoy, the way will then be opened for really satisfactory relations between these corporations and the public which they serve.

LETTERS TO THE EDITOR.

Dangers of the St. Lawrence Route.

Sir: Regarding your comments on the "Dangers of the St. Lawrence Route," in your issue of Oct. 2, it is hardly fair to attribute to the St. Lawrence the accidents taking place in the vicinity of St. John, N. B., Halifax and Sydney, N. S., and St. John's, Newfoundland; all of these being Atlantic ports and not connected in the slightest degree with the river or gulf of St. Lawrence. I think it is only fair to add that owing to the competition between export shipping of St. John and Halifax to England, there is a tendency on the part of St. John steamers to keep too close to the well-known dangerous south coast of Nova Scotia. This has perhaps been the cause of more than one total loss, and should be considered as a factor in the estimation of the safety of the route.

Yours truly, A. C. D. Blanchard

Niagara Falls, Ont., Oct. 4, 1902.

(We confess that the heading given to the item was rather misleading, since only the last sentence referred to the St. Lawrence route.—Ed.)

Timber Lining for Canals in Earth Excavation.

Sir: In your issue of Sept. 25 last, in describing the water-power canal of the Michigan-Lake Superior Power Co. at Sault Ste. Marie, you speak of the plank and timber lining of the canal as "a remarkable and wholly unprecedented feature of the construction." It is, I think, wholly unprecedented, but as a remarkable coincidence the same feature was adopted at about the same time by the Seattle & Lake Washington Waterway Co. for its ship canal designed to connect the waters of Puget Sound with those of Lake Washington, near Seattle, Wash. The object was the same, also; that is, to prevent erosion by currents.

At Seattle a necessity exists for maintaining a large lake at its normal level in order to prevent inundation of adjacent lands during the rainy season. In order to accomplish this desirable result, a swift current must be admitted in the canal during certain months, and to prevent damage to the bottom and slopes of the canal prism the plank and timber lining was designed.

Very respectfully, Eugene Semple.

Bailey Building, Seattle, Wash., Oct. 6, 1902.

The First Water Closets West of the Alleghany Mountains.

Sir: There is on exhibition in a plumbing shop in Cincinnati what is said to be the third water closet that was put in place west of the Alleghany Mountains. It is a pan closet, closely resembling many of that style in use to-day, but of exceptionally heavy and rough construction. It with two others of the same construction were placed in private residences in Cincinnati in 1843. They were installed by the senior member of the plumbing firm which has one of the closets now on exhibition.

It seems hardly possible that within the lifetime of a

man now living there should be such an enormous growth in the use of this fixture which is now so important in the sanitary problem of the cities and even of the small villages. That this distinction should fall to Cincinnati is not surprising when it is recalled that this city was in 1840 the fifth largest in the United States, and much larger than any other city, except New Orleans, lying west of the Alleghany Mountains. Very truly yours,

Benj. H. Flynn,
Engineer Ohio State Board of Health.

Columbus, O., Oct. 8, 1902.

Forcing Cement Into Quicksand by Air Pressure.

Sir: We would like very much to learn something of the process of blowing cement into the sand of river beds for the purpose of solidifying the same. Will you kindly give us some information on the subject? Yours truly,

Beardsley Construction Co.,
By R. C. Beardsley.

Elkhart, Ind., Oct. 4, 1902.

[We are able to give no information relative to a pneumatic process of forcing cement into quicksand. Possibly our correspondent has in mind the Harris process of pumping cement grout into quicksand. This process was patented by the late Robert L. Harris, M. Am. Soc. C. E. (patent No. 464,771, Dec. 8, 1891), and was described in our issues of Apr. 28, 1892, and June 28, 1894. The process consists of (1) sinking pipes into the quicksand; (2) pumping out the sand so as to leave a chamber, and (3) forcing cement grout into the chamber, so that a hard cemented floor is produced. If any of our readers know of any process of forcing cement into quicksand by air pressure we shall be pleased to hear from them.—Ed.]

A Query as to the Value and Significance of Certain Cement Tests.

Sir: In your issue of Sept. 25, I have read with interest your description of cement tests made by the New York Rapid Transit Railway Commission. I notice that in the test for soundness, pats of neat cement molded upon glass plates and allowed to set in air for 24 hours, and then put through the cold water and boiling tests, are expected to adhere to the glass at the end of the tests. I have found that in good and bad cements alike, a majority of the pats do not adhere to the plates, when they are perfectly clean. May I ask what conclusion the commission draws in this case?

I would like to know, as well, how much confidence cement testers place in the boiling test. I have in mind a test of six samples of cement, five of which went to pieces in the boiling test. Upon a retest from the same six sample boxes, under exactly the same conditions, the five samples above mentioned came through the boiling test perfectly sound. All other required tests on these six samples were entirely satisfactory. In another case cement which set in less than 10 minutes and did not meet tensile requirements passed the boiling test.

I would also request some of your readers to throw light upon one other point. Are flasks for measuring water made graduated to avoirdupois as well as apothecaries measures? Using the common apothecaries' flask adds an extra operation to obtain the correct per cent. of water to that of cement or cement and sand.

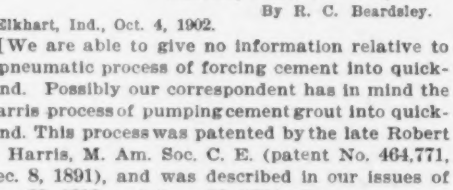
Very respectfully, H. A. Young, C. E.

Tuscaloosa, Ala., Oct. 5, 1902.

A Device for Testing an Elevator Air Cushion.

Sir: I noticed the interesting account in your last issue of the test of an elevator safety air cushion in the Philadelphia City Hall tower and your comments thereon. Permit me to suggest a simple method by which a real test of such a cushion may be made. The spectacular "egg test," as you well show, amounts to nothing.

Support a weight of 150 lbs. on three helical springs of such dimensions that they will be about 6 ins. high when



A Device for Measuring the Force of Retardation.

loaded with 50 lbs. each (the static weight of the slab resting on them) and 4 ins. high when loaded with say 750 lbs. each. Place under the center of the load a cylindrical plug, sliding, with some friction, in a hole in a wooden block. Let the weight when quietly resting on the springs push the plug a short distance into the hole, and measure the distance the plug extends out of the hole. When the elevator falls and is brought to rest by the air cushion, the maximum compression of the springs will be measured by the distance the plug has been pushed in. Then by merely piling weights on top of the 150-lb. weight until the deflection of the springs equals the maximum recorded deflection, we may know what weight a 150-lb. man would have to support.

Of course this would still leave unsettled the question how many times his own weight a man can safely sustain when subjected to retardation such as that effected by the air cushion. It seems a great pity—on this and other accounts—that the yellow journal reporter who was so anxious to accompany the rats in the falling elevator car at Philadelphia the other day was not permitted to do so.

Very truly, K. W.

New York, Oct. 9, 1902.

The Effect on Meadow Lands of Back Water from Dams.

Sir: Your correspondent "S. P. D.," in Engineering News of Sept. 11, may get some light from my article on the "Effect of an Obstruction on Silt Bearing Streams," which appeared in Engineering News of Aug. 15, 1901.

Respectfully, Elmo G. Harris.

University of Pennsylvania,
Philadelphia, Sept. 16, 1902.

For the convenience of our readers we reprint the conclusions to the article named, as follows:

A stream flowing through alluvium will, by cutting away the material of its channel at some places, and silting up at others, finally establish for itself a definite slope, or grade, dependent on the volume of water flowing and on the character of the material through which the channel is cut. Any steeper grade will cause erosion; any less will allow deposit of silt. Hence such a stream must finally re-establish this definite grade after an obstruction has either been put in or taken out; in the former case by silting up, in the latter by cutting down. The new surface line being parallel to the first the change must extend upstream to where the first is broken, be that near or far.

Sir: In reference to the inquiry of S. P. D., in Engineering News of Sept. 11, in regard to the effect on meadow lands of back water fro ma dam, a somewhat dissimilar but very interesting case has recently arisen in the writer's experience. Names, dates and places are not given for obvious reasons.

A farmer owned land below the 20-ft. contour (see sketch plan) east of the highway and south of the railroad. This land was always subject to overflow at high stages of the river, but had been very productive up to the time, and even for some years after the time, the railroad was constructed through the land.

But of late years the land has become swampy and wet the year around, and it is now impossible to raise at all the same crops that were formerly produced in abundance.

The farmer had collected from time to time various sums from the railroad to compensate him for the overflow and for the spoiled drainage of his land, and the railroad had dug alongside its embankment an expensive artificial channel in an effort to drain this land.

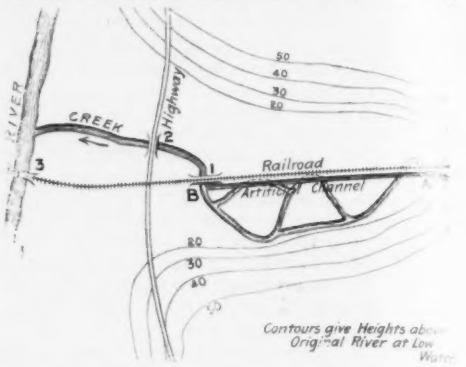
Finally the railroad refused to pay the amount of the continually increasing demands of the farmer. The latter brought suit, and the writer was called on to examine the situation and to qualify as a witness for the railroad.

On the occasion of the writer's examination the conditions on the ground were about as follows: The creek shown extended back east of the point A, some 15 miles, and drained a rolling, arable and fertile country. The artificial channel, A B, had been made amply large to carry the creek water in all ordinary stages, but not large enough to carry it in extreme floods. Neither was the old channel of the creek sufficient to carry the creek water in flood time, and the artificial channel was larger than the natural one. The old channel had been left open except where the railroad embankment crossed it. The artificial channel was nearly a mile long and its west end was about two miles from the river.

The lower end of this artificial channel, near B, and all the old creek bed channels all the way from A to Bridge 2, had filled in so there was practically no channel left, and now a very ordinary rain floods the land. Formerly a ford of the creek had passed under Bridge 2 and wagons loaded with hay were driven under the bridge. Now the channel is filled in so that a tall man cannot stand upright under the stringers. Bridge 1 was more than ample to pass any flood likely to arise from the area drained. In a local flood just preceding the writer's examination the flood water after passing beneath Bridge 1 had turned back directly east on the north side of the railroad. There was no evidence whatever that the waterway of this bridge had choked or clogged the stream.

The writer concluded, and testified in court, that the railroad was clearly not responsible for the spoiled drainage of the land, though its officers and the farmer had believed and for years acted upon the supposition that it was. The explanation of the spoiled drainage of the land was given as below: A dam in the river several miles below Bridge 3, constructed shortly before, or about the time the railroad was, together with another cause for which the railroad was in no wise responsible, had jointly contributed to raise the low water level of the water in the river a little more than 6 ft. East of the point A the creek had a good fall and even ordinary rains brought water heavily silt-laden from the arable fields above. This water, of course, deposited its silt in the various channels whenever and wherever its velocity was checked by the river back water. This silt can not now be formerly be removed by a second rain, since the rains does not now go down to give the creek water a chance to wash it out as formerly. Thus in time the channels were all filled and the water from even an ordinary rain backed to the fields."

To sum up, then: The drainage was spoiled because all the channels, both natural and artificial, were filled in, and the channels were filled in from causes with which



Sketch Plan Illustrating Damage Suit for Submerging Land.

the railroad had nothing to do. Therefore the railroad was no more responsible for the spoiled drainage of the land than for the extension of the land into the gulf at the mouth of the Mississippi.

So far the writer felt sure of his ground. But the land in dispute was all from 16 to 20 ft. above river low water, and the testimony showed that in very dry seasons, when no water to speak of came down the creek, and the river water remained throughout the season well below the level of the land, the farmer even then could not cultivate his land.

The writer testified that *in his judgment* the explanation was that the underdrainage had been interfered with by the general rise of the river level and by the filling in of the various channels.

On cross-examination he was asked with some sarcasm by the farmer's attorney if he *really believed* a 6-ft. rise in the river low-water level could affect the underground drainage of a piece of land two miles away from and 20 ft. above the river.

W. D. Taylor, Professor Railway Engineering,
University of Wisconsin.

Sterling Court, Madison, Wis., Sept. 26, 1902.

Sir: We enclose you herewith pamphlet and blue print respecting the query by your correspondent, S. P. D., Drake's Branch, Va., in your issue of Sept. 11.

We have had several of these cases, all of which have been settled in court favorably. We refer in the accompanying pamphlet, p. 27, to the case Hines vs. Jarret, which went up to our Supreme Court. The hydraulic principle involved is explained on pp. 22 to 27 (reprinted herewith—Ed.); and the full history of a case is given on pp. 44 to 51, covering nearly five miles of a stream. The latter case was settled out of court on the strength of the Hines vs. Jarret case, but was a more complete demonstration of the hydraulic principle involved than either of the other cases cited.

We enclose a blue print of the Brock vs. Wingo case, which was recently decided in favor of our client. In the profile you will note one line marked "Water Surface, June 26, 1897, Scour Line, June 6 to June 26, 1897." This shows the scour in the stream due to a break in the dam between the dates specified. The profile also shows the original gradient and the position of shoals on the stream prior to the erection of the dam, and the various slope lines show the fill in the stream due to the obstruction caused by the dam. The line marked "Present Surface of Water in Stream as Found by Water Line," is the one located at the date of last surveys in March, 1898, several months after the dam had been repaired.

The hydraulic principle involved is very clearly shown in this case if compared with the explanation given in the pamphlet, pp. 22 to 27 (reprinted herewith—Ed.).

You will note that the stump shown on this print just below Brock's line is very conclusive evidence of the fill in this stream as affected by the dam shown.

We beg to say further that this principle is very far reaching, since there is no limit to the fill in a stream due to an obstruction, except a shoal or shoals aggregating the height of such obstruction. We have found it difficult for some very intelligent engineers and lawyers to grasp this idea, but it is perfectly rational and only too plain when properly understood, and we now have a number of cases which can be cited demonstrating this

fact most conclusively. There is certainly no other limit than that given by our rule. Very truly,

Geo. E. Ladshaw.

Spartanburg, S. C., Sept. 15, 1902.

(The principles laid down in the pamphlet entitled "Hydraulic Notes," sent by our correspondent, are given immediately below.—Ed.)

MOVEMENT OF SILT AND SAND IN THE CHANNEL, OR TRACE, OF A STREAM, AND CAPILLARY ACTION.

GENERAL PRINCIPLES.—On approaching the source of a stream, all conditions remaining the same, the grade steepens, due of course to a decrease in the volume of water discharged. Such a gradient is manifestly convex to a horizontal line passing through the lower end of any reach of a stream and is said to be characteristic, i. e., has no limiting conditions other than decrease of volume. This curve is said to be broken when its convexity to a truly level line is limited at any point—shoal—or its value as a factor of the gradient becomes zero—level—or cuts the horizontal and becomes minus zero—fall. A hydraulic gradient is said to be normal when unaffected by artificial or temporary obstructions. These are self-evident propositions, since the grade of a stream is a function of all the other conditions obtaining; and the conclusion is further drawn that the fall in feet per mile over any reach of a stream is a result only of any or all of the other conditions obtaining therewith.

"The hydraulic gradient of any stream is due to the volume of water discharged and the physical character of the country traversed, as to erosion, modified by its transverse cross-section and regimen."

The above is an established principle of hydraulics. Hence a given volume of water may pass over a rocky bed at any inclination above a horizontal, and at any velocity less than that due to gravity only. In such case there is no hydraulic grade from the conditions specified because the factor of erosion is infinite, in other words impossible.

The same volume of water may flow through a swamp, not confined within banks, having a grade of 1% or more. This condition is a possibility only and is not, as stated, subject to the laws of hydraulics as applied to streams, seeing such a surface may differ very little from an absolute level, and vice versa.

The same volume of water may pass over a bed of great width (the width between banks being equal to the wetted perimeter), easily eroded, confined within banks, having a grade of .005% or more. The same volume of water may pass through a channel, easily eroded, and confined within banks, in which the wetted perimeter is much greater than the surface width, good order and regimen, having a grade of .10-in. per mile and a barely perceptible current. *Vide* "Hydrographic Survey of the River Ganges."

All streams assume a certain gradient in accordance with the above law. It follows, then, the hydraulic gradient of any stream may be altered by artificial means, and, all conditions remaining the same, an obstruction, dam, log, drift, etc., will elevate the gradient of a stream to the extent of its vertical height above such gradient, plus the sine of the angle of curvature of such gradient, and no more. But should such obstruction exceed the height of the banks and consequently contiguous low lands, the alteration in the gradient would practically cease when the fill over the stream subject to such alteration equalled the height of its bank. The bed of the stream then partakes of the nature of swamp and not subject to erosion—a condition governed by the effect of freshets which tend to leave the stream a certain trace through its valley. The elevation of the gradient is only retarded, however, and the possible fill increased, due to the change in the ratio of the wetted perimeter to the surface width. Thus the primary condition as a result of such obstruction affecting the normal gradient, suffers a change, due to an alteration in the transverse cross-section of the stream (subdivision or "great width"); the effect being to steepen the gradient and thus carry the fill still farther up stream. The foregoing treats the subject by stages, as it is the primary stage only which is sufficiently rapid to become perceptible.

The ultimate condition as a result of placing a permanent obstruction in the trace of a stream is to elevate the normal gradient equal to the vertical height of such obstruction above such gradient, and the contiguous bottom-land above this, equal to the original height of such lands if alluvial, above the original gradient: It does not matter whether the bottom lands are alluvial or only partly so. There may be high ridges through them not so deposited, in such case the fill would tend to make such surface even. It is here taken that the land contiguous to the trace of the stream is an alluvion.

The extension of the fill up stream is limited only by a shoal, or shoals, the aggregate heights of which, above the normal gradient at such shoals, equals the height of such obstruction, plus the sine of the angle of curvature of the gradient. This is equal to twice the height of the obstruction plus the sine, etc.

This is as it should be, since the obstruction referred to is opposed to natural conditions and the effort on the part of nature is to reproduce the original conditions as above specified. Moreover, a year or less is often sufficient time for a stream to correct its gradient due to an obstruction, dam, etc., to the extent of the depth of its banks, but beyond this the process is very slow, requiring ages, even if possible. This result, however, is purely scientific and has no practical value as a factor in this discussion.

CAPILLARY ACTION.—Water rises in the soil above the level of permanent water, bed of stream, in accordance with the laws of capillary attraction. That is to say: "inversely as the radius of the tube," or, in other words, inversely as the porosity of the soil. Hence we find, by actual observation, that water will rise by capillary attraction less than ⅛-in. in clean sand and more than 6 ft. in a stiff, tenacious clay. This explains the effect of raising the gradient of the bed of a stream on adjacent bottom lands and the cause of wet places in low land.

Experience shows that arable bottom lands in this country require an elevation of from 2 to 4 ft. above surface of water in stream. This is about the average. Different soils may require more or less elevation, as above stated.

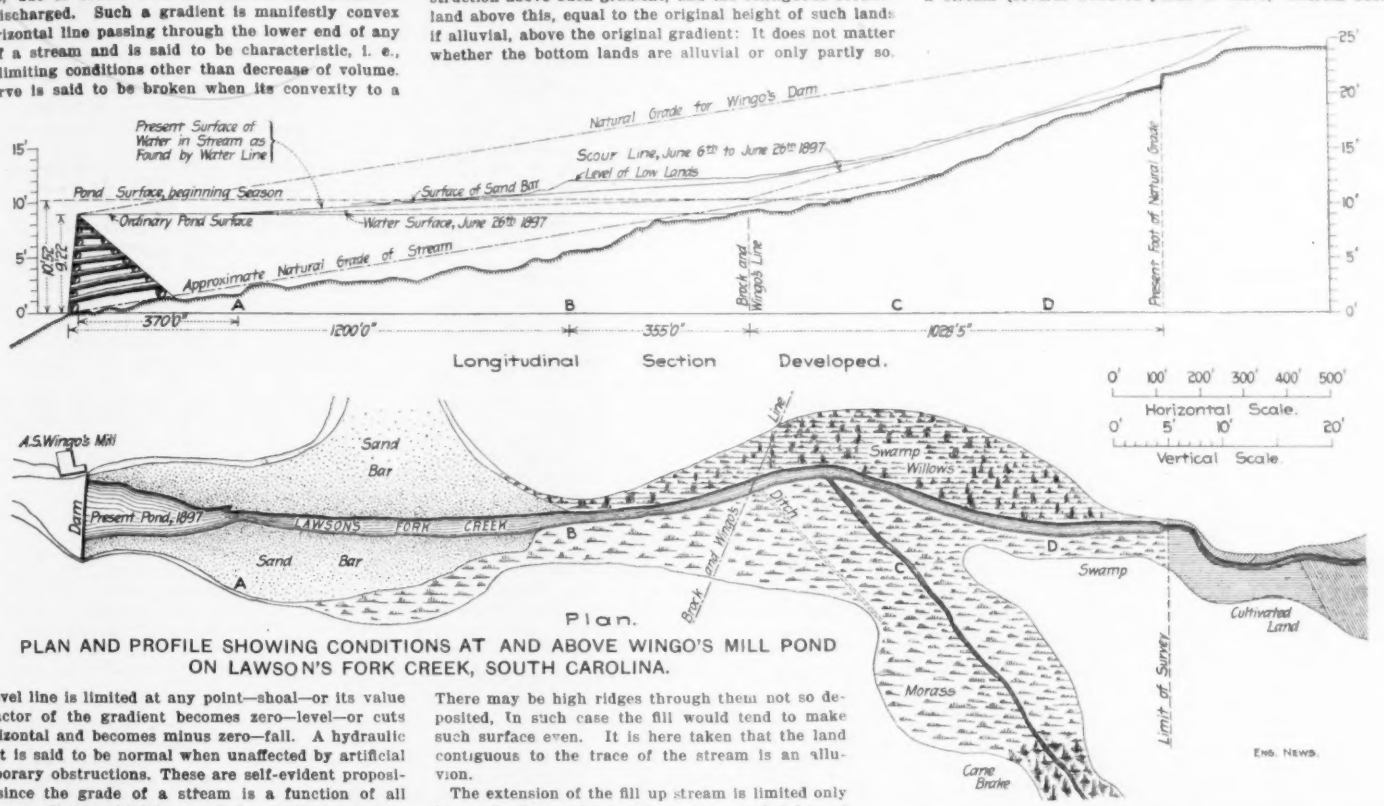
The effect of capillary attraction in any soil is to elevate the permanent water level in that soil to the extent of such action. Hence, lands that are wet through capillary attraction cannot be drained by ditching, no matter what fall there may be, because the permanent water level in any soil cannot be lowered except through the source of supply—surface of water in stream or other source of water in soil. A ditch through a marsh, or more particularly through land in which the water rises to the surface by capilliary attraction, drains but a narrow strip on each side of such ditch, more often less than 2 ft. wide than more, which is shown by the character of the vegetation.

EXPERIMENTS AND CONCLUSIONS.—Several experiments were made on small streams to reach the above conclusions and numerous observations on obstructions in large and small streams which verified results so obtained in a very satisfactory manner. It was found that where the obstruction did not materially alter the cross-section of the wetted perimeter the limit of the fill up stream would rapidly reach a point in the bed of same very approximately twice as high as the obstruction above the bed of the stream at the obstruction, provided the gradient of the stream was broken by a shoal or shoals aggregating the height of such obstruction, otherwise the fill up stream would continue indefinitely, or until such shoals or breaks in the gradient occurred, and the height of the surface of the water where the fill ceased above the surface of the water on the crest of the obstruction was approximately equal to the distance from the surface of water on crest of obstruction to the surface of water at base of same.

Of course it would be difficult to find any long reach of a stream (several hundred yards or more) wherein such conditions of cross-section would be maintained during the filling by silt and sand, but by using obstructions of suitable height and short reaches (less than 100 ft.) where shoals or falls existed on such reach, breaking the hydraulic gradient and aggregating the height of such obstruction, the work could be accomplished in a few days, and we consider the principle quite clearly established. This conclusion was further verified by observations on drift and dams in stream channels with high banks, which further demonstrated that the bank full stage of the fill in any stream is the practical limit, though only arrested at that point by a change of conditions in the trace and regimen of the stream.

We have had no opportunity to verify the absolute limit of fill due to an obstruction placed in the channel or trace of a stream as defined by the postulate above given, but the curvature of the hydraulic gradient of streams and limit of fill due to an obstruction is demanded by theory and has been established by accurate levelings on long reaches of many streams, and since the fill in any stream is a function of its gradient, it cannot cease until the condition specified has been reached. Hence the conclusion that the only limiting condition respecting the deposit of silt and sand in the trace of a stream and its recession up stream is a shoal or shoals, breaking the hydraulic gradient and aggregating the height of the obstruction causing such deposit plus the sine of the angle of curvature of such hydraulic gradient.

From a legal standpoint this principle was established in law in so far as the right of a riparian owner to the flow of silt and sand through or by his premises is concerned. See Hines vs. Jarrett, 26 S. C. 480, Shand 1886-7.



PLAN AND PROFILE SHOWING CONDITIONS AT AND ABOVE WINGO'S MILL POND ON LAWSON'S FORK CREEK, SOUTH CAROLINA.

Notes and Queries.

We are asked by Mr. B. G. Lamme to correct an error in his paper, "The Washington, Baltimore & Annapolis Single-Phase Railway," abstracted in our issue of Oct. 2. The paper stated that the engineers for the road were the Cleveland Engineering Co.; this should read Cleveland Construction Co.

Our attention has been called to an error in our issue of Oct. 9, p. 304, fourth line from bottom of column, the last five words of which should be changed to read "which expenses, capitalized, would represent millions," etc.

This error appeared in the article on "Proposed Further Development of Underground Water Supply for Brooklyn," reprinted from the recent report of Mr. T. M. de Varona, of Brooklyn. The error was repeated from the original.

A STEAM TURBINE will be used at Providence, R. I., to generate electricity to drive a centrifugal pump to lift water to the new slow sand filter beds now under construction near the Pettaconsett pumping station of the city water-works. The De Laval turbine and direct-connected generator will be located in the existing pumping station. Wires will lead across the river to an electric motor in a secondary pump house, where water from the Pawtuxet River will be lifted to the filter beds.

DETERMINING THE SIZE OF HOISTING-PLANTS.*

By Edward B. Durham, M. Am. Inst. Min. E.†

It is often necessary to calculate the size of a hoisting plant required to raise a given quantity of material, either as a preliminary to the detail design of the machinery, or to decide whether machinery on hand or offered by a manufacturer is adapted to the work to be done.

The first element of the problem to be determined is the load to be raised. In a mine that is already developed, this is limited by the size of car that can be hoisted out of the mine, and that will pass through the underground gangways. If these place no limits on the design, the size of the load will depend on the output desired per day, and on the number of hoists that can be made per day. The latter are fixed by the time required per hoist and the number of hours available for hoisting, after deducting from the working day the time required for raising and lowering men, sending down supplies, and for the many small delays in handling cars. It must also be decided whether the hoisting is to be done in one shaft or in all of them.

As an example, assume an output of 400 tons per 10 hrs.; shaft, with two compartments, 1,000 ft. deep; hoisting in balance; time available for hoisting, 6 hrs.; engine can hoist load in 1.5 mins., and time to change cars, 0.5 min. (the change at top and bottom of shaft being made at the same time). Then, 30 cars can be raised per hour, or 180 cars in 6 hrs. This would require cars of 400 ÷ 180 = 2.22 tons capacity, to handle the desired output.

With a single shaft, the time to raise one load is the time to change or load cars at the bottom, hoist loads, change cars, or dump at the top and lower the empty cars; while, in a double shaft, two cars could be handled while the above programme was being carried out in a single shaft, as the second load would be raised while the first empty was going back down, and changing of cars at the top and bottom would be going on simultaneously.

ROPES.—Having settled the size of the useful load to be hoisted, the size of the rope must be determined. This must be strong enough to hoist the total load, including its own weight, and to withstand the starting stresses due to picking up the load suddenly when the rope is slack. Experiments have shown that, in starting with 6 ins. of slack rope, the stress in the rope is about double that due to picking up the load gently. Expressing these stresses in a formula, let

K = stress in rope in pounds, at the head sheave, at the instant of picking up the load;
W = weight of gross load in pounds;
R = weight of rope in pounds;
F = friction in pounds = weight of all moving parts multiplied by f;
f = coefficient of friction.

Then

$$K = 2W + R + F. \qquad (1)$$

This stress should not exceed one-seventh of the ultimate strength of the rope. The coefficient of friction, f, may be taken at .01 for vertical shafts, and as .02 to .04 for inclined shafts with rope well supported on rollers.

As an example, required to find size of rope necessary to hoist a total load of 5,000 lbs. from a vertical shaft 1,500 ft. deep. Assume, for a trial solution, that rope weighs 2 lbs. per ft. From equation (1),

$$K = 5{,}000 \text{ lbs.} \times 2 + 1{,}500 \times 2 \text{ lbs.} + .01 \times 8{,}000 \text{ lbs.} = 13{,}080 \text{ lbs.},$$

and ultimate strength of rope should be

$$7 \times 13{,}080 = 91{,}560 \text{ lbs.},$$

which would require a 1¼-in. diameter flexible cast-steel rope, having an ultimate strength of 100,000 lbs, and weighing 2.45 lbs. per ft. This weight would increase R in above equation, and make 7 × K = 96,285, which is still less than the ultimate strength of the rope chosen. If a lighter-weight rope is desired, a plow-steel rope could be used instead of the cast-steel.

If the shaft is inclined, the stress in the rope due to the weight hoisted will vary with the sine of the angle of inclination, thus:

$$K = (2W + R) \sin x + F. \qquad (2)$$

in which x is the angle of inclination. Here the friction is also affected by the slope, and varies with the cosine of x, or F = f (W + R) cos x; f may be taken at .02.

In the following discussion the loads will be considered as being hoisted from vertical shafts, as the principle remains the same for both classes, the only difference being that the stresses in the rope and on the engine and other parts of the machinery change with changes in the slope.

DRUMS.—The minimum diameter of the drums is determined by the size of the rope used, and the larger the drums the smaller will be the bending stresses and the more strength will be available for useful work.

Mr. William Hewitt has shown that, when the diameter of the sheave or drum is 44.5 times the diameter of a 19-wire cast-steel rope, the bending stresses are ⅔ and the remaining useful strength is ⅓ of the "maximum safe load" that the rope will carry. The "maximum safe load" is taken as ⅓ the ultimate strength, which is about the elastic limit of the wire. Or the available strength is only 1/9 of the ultimate. In order to cut down the bending stresses so as to leave ⅓ of the ultimate strength of the rope available for useful work, the sheaves must be about 80 times the diameter of the rope. Other grades of rope require different diameter of drums, as will be seen by studying Tables I. and II.

Table II. is based on the formula

$$k = \frac{E\,a}{2.06\,\frac{R}{d} + C},$$

in which k represents the bending stress in pounds, E the modulus of elasticity = 28,500,000, a the aggregate area of the wires in square inches, R the radius of the bend in inches, d the diameter of the individual wires in inches, and C a constant depending on the number of wires in the strand. The values of d and C are, for 19-wire hoisting rope: d = 1/18 diameter of rope, and C = 45.9.*

As an example, required the working load of a 1-in. cast-steel rope running over a 6-ft. sheave. From Table II. the bending stress is found to be 9,937 lbs., and from Table I. the "maximum safe stress" is found to be 22,667 lbs., and the difference is 12,730 lbs. as the working load.

The size of the rope fixes the minimum diameter of the drum, but the question of speed and length of drum also influence the final choice of the diameter.

The maximum length of a drum, aside from question of room, is controlled by the allowable fleet-angle, that is, the acute angle included between two lines drawn from the ends of the drum to the head sheave. This angle should not exceed 6°, in order that the rope may lead well on to the head sheave, and so that one rope will not grind or mount the next one in winding onto the drum. It is usual to place the drum far enough back from the head sheave to keep the fleet-angle within the limit; but where it cannot be done, it is necessary to guide the rope onto the head sheave and onto the drum by rollers or sheaves running on vertical spindles. The bisectrix of the fleet-angle should strike the middle of the drum.

TYPES OF HOISTING ENGINES.—Single cylinder engines are used in mining to replace man or animal power for light work. They are always geared and provided with a flywheel on the crank shaft. They must be started to a fair speed, in order that the flywheel may develop sufficient momentum to carry the crank over the center, before the friction is thrown in to pick up the load. The cylinder should have 75% more power than is necessary to simply raise the load, in order that speed may be maintained.

Double-cylinder engines are used for all the regular work of mining. They may be divided into the following classes:

I. Geared—Single cylindrical drum; double cylindrical drum; double conical drum.

II. Direct-Acting—Single cylindrical drum; double cylindrical drum; double conical drum; Koepe system; reels for flat rope.

Each of these has a field of its own to which it is best adapted. Thus, the geared engine is used mostly for shallow depths and small outputs per day, while the direct-acting engines is used where the output is large. There are many cases near the dividing line, in which either type of engine will give equally good results, and it is largely a matter of personal choice as to which is used.

Geared engines are made with small cylinders, and the engine proper runs at a speed of 100 to 200 revs. per min. The gearing usually gives a reduction of ⅓ to 1/10, so that the drum revolves at a moderate speed. The small cylinders make the first cost lower than that of a direct-acting engine; but the gearing for large hoists is a serious objection. The main gear has about the same diameter as the drum, so as to keep the pressure on the teeth as low as possible; and hence it has a circumferential speed equal to the speed of hoisting. Gearing, under very favorable conditions, should not run at a speed over 1,200 ft. per min., and with the large cast gears and the rough work to which hoisting-engines are subjected, the speed should probably not exceed 900 ft. per min. If the average speed of hoisting is kept at about ⅔ of this maximum, the average speed will not exceed 600 ft. per min. This speed will allow the use of moderate-sized drums and keep the piston speeds within the limits of good practice.

That gearing is liable to cause trouble and make con-

*A paper read before the American Institute of Mining Engineers.

†Trenton Iron Co., Trenton, N. J.

*Tables I. and II. were calculated by Mr. William Hewitt, and are published here by his permission. The original, with other data on wire ropes, appeared in a pamphlet entitled "Wire Rope and Its Application to Power Transmission," 1901, issued by Trenton Iron Co., Trenton, N. J., from whom copies can be obtained.

TABLE I.—Hoisting Ropes = 6 Strands of 19 Wires Each.

Diameter in Inches.	Approximate Circumference in Inches.	Estimated Weight per Foot in lbs.	Iron. Approximate Breaking Stress in lbs.	Iron. Max. Safe Stress in lbs. = ⅓ Ult. Stress.	Cast-Steel. Approximate Breaking Stress in lbs.	Cast-Steel. Max. Safe Stress in lbs. = ⅓ Ult. Stress.	Extra Strong Cast Steel. Approximate Breaking Stress in lbs.	Extra Strong Cast Steel. Max. Safe Stress in lbs. = ⅓ Ult. Stress.	Plow-Steel. Approximate Breaking Stress in lbs.	Plow-Steel. Max. Safe Stress in lbs. = ⅓ Ult. Stress.	Proper Working Load.
2¼	7⅛	8.00	156,000	52,000	312,000	104,000	364,000	121,333	416,000	138,667	Max. safe stress less bending stress determined by Table II.
2	6⅜	6.30	124,000	41,333	248,000	82,667	288,000	96,000	330,000	110,000	
1¾	5½	4.85	96,000	32,000	192,000	64,000	224,000	74,667	256,000	85,333	
1⅝	5	4.15	84,000	28,000	168,000	56,000	194,000	64,667	222,000	74,000	
1½	4¾	3.55	72,000	24,000	144,000	48,000	168,000	56,000	192,000	64,000	
1⅜	4¼	3.00	62,000	20,667	124,000	41,333	144,000	48,000	164,000	54,667	
1¼	4	2.45	50,000	16,667	100,000	33,333	116,000	38,667	134,000	44,667	
1⅛	3½	2.00	42,000	14,000	84,000	28,000	98,000	32,667	112,000	37,333	
1	3	1.58	34,000	11,333	68,000	22,667	78,000	26,000	88,000	29,333	
⅞	2¾	1.20	26,000	8,667	52,000	17,333	60,000	20,000	68,000	22,667	
¾	2¼	0.89	19,400	6,467	38,800	12,933	44,000	14,667	50,000	16,667	
⅝	2	0.62	13,600	4,533	27,200	9,067	31,600	10,533	36,000	12,000	
½	1¾	0.50	11,000	3,667	22,000	7,333	25,400	8,467	29,000	9,667	
⅜	1½	0.39	8,800	2,933	17,600	5,867	20,200	6,733	22,800	7,600	
⅜	1¼	0.30	6,800	2,267	13,600	4,533	15,600	5,200	17,700	5,900	
⅛	1⅛	0.22	5,000	1,667	10,000	3,333	11,560	3,853	13,100	4,367	
¼	1	0.15	3,400	1,133	6,800	2,267	8,100	2,700	.....	.....	
⅛	¾	0.10	2,400	800	4,800	1,600	5,400	1,800	.....	.....	
Tensile strength of wire per sq. in.			75,000 to 90,000 lbs.		150,000 to 200,000 lbs.		190,000 to 225,000 lbs.		225,000 to 275,000 lbs.		

TABLE II.—Bending Stresses 19-Wire Rope.

Diam. of Bend.	6	8	10	12	14	16	18	20	22	24	26
Diam. of Rope.											
⅜	1,801	1,390	1,131	965	827	728	654	586	535	495	455
½	3,308	2,568	2,098	1,774	1,536	1,355	1,212	1,096	1,000	920	852
⅝	.....	3,776	3,094	2,620	2,273	2,006	1,796	1,626	1,485	1,366	1,265
¾	.....	.....	5,351	4,546	3,951	3,494	3,132	2,838	2,594	2,389	2,214
⅞	.....	.....	.....	6,609	5,755	5,096	4,573	4,147	3,793	3,495	3,241
1	.....	.....	.....	.....	8,337	7,393	6,642	6,029	5,519	5,089	4,721
1⅛	.....	.....	.....	.....	11,565	10,270	9,237	8,392	7,689	7,095	6,586
1¼	.....	.....	.....	.....	.....	13,360	12,027	10,936	10,027	9,257	8,597
1⅜	.....	.....	.....	.....	.....	.....	15,309	13,932	12,782	11,807	10,971
1½	.....	.....	.....	.....	.....	.....	.....	21,403	19,662	18,183	16,910
1⅝	.....	.....	.....	.....	.....	.....	.....	.....	.....	27,612	25,707
1¾	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35,620

Diam. of Bend.	28	30	36	48	60	72	84	96	108	120
Diam. of Rope.										
¼	423	398	338	250	200	167	144	126	112	101
⅜	795	742	621	468	376	314	270	236	210	189
½	1,178	1,102	924	698	561	469	403	353	314	283
⅝	2,063	1,931	1,620	1,226	986	824	708	621	553	498
¾	3,021	2,829	2,376	1,800	1,448	1,212	1,042	913	813	733
⅞	4,403	4,125	3,468	2,630	2,118	1,773	1,525	1,338	1,191	1,074
1	6,145	5,759	4,847	3,680	2,967	2,485	2,137	1,876	1,671	1,506
1⅛	8,024	7,524	6,201	4,818	3,886	3,257	2,802	2,459	2,191	1,976
1¼	10,245	9,609	8,101	6,165	4,977	4,173	3,591	3,153	2,809	2,534
1⅜	15,805	14,835	12,528	9,556	7,724	6,481	5,583	4,886	4,371	3,943
1½	24,047	22,589	19,113	14,614	11,830	9,937	8,566	7,528	6,714	6,059
1⅝	33,347	31,347	26,566	20,357	16,509	13,872	11,966	10,523	9,387	8,474
1¾	.....	42,036	35,683	27,400	22,289	18,713	16,153	14,209	12,682	11,452
1⅞	.....	.....	48,109	37,028	30,096	25,350	21,897	19,272	17,209	15,545
1½	.....	.....	61,238	47,229	38,436	32,403	28,008	24,662	22,030	19,906
1⅝	.....	.....	.....	59,094	48,152	40,629	35,140	30,967	27,664	25,005
1¾	.....	.....	.....	74,565	60,844	49,919	44,476	39,203	35,048	31,689
1⅞	.....	.....	.....	90,325	73,795	62,379	54,022	47,639	42,606	38,534
2	.....	.....	.....	.....	88,409	74,795	64,814	57,183	51,160	46,285
2¼	.....	.....	.....	.....	125,387	106,265	92,203	81,428	72,908	66,002
2½	.....	.....	.....	.....	.....	145,246	126,185	111,546	99,951	90,540

derable noise when run at a high speed, has been forcibly impressed on the mind of the writer by his experience in charge of a geared hoister, made by a reliable manufacturer, having cylinders each 18 ins. diameter by 24-in. stroke, and two drums, each 7 ft. 6 ins. diameter by 5-ft. face, on which three main gears, between 7 and 8 ft. diameter, 3-in. pitch, and 9-in. face, were broken inside of nine months. The gears cost about $300 each, besides the labor of replacing and the loss of 24 hrs. to change the old for a new one. The engine was hoisting from a shaft 600 ft. deep in about 1¼ mins. The load of ore was 2½ tons.

Direct-acting engines should not be used for hoisting speeds of less than 500 ft. per min., as the piston-speed will be too slow for economy. They can readily be run at an average speed of 1,500 ft. per min., and the largest

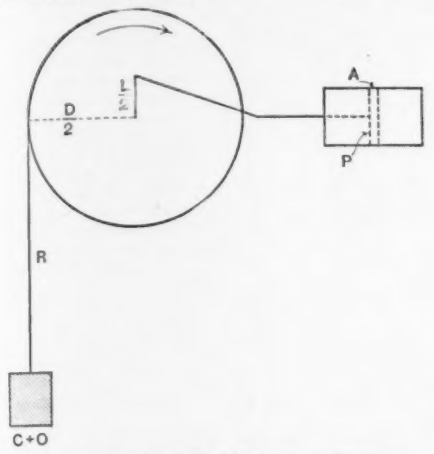


Fig. 1. Single Cylindrical Drum Engine.

engines can run in deep shafts as much as 2,500 ft. per min.

Single-drum engines are limited to small outputs per day, or to places where the first cost of the plant is so important as to outweigh the loss in increased operating expenses. This type of engine has many applications, as for sinking winzes, and for other inside work; also for shaft sinking, and for working coal mines on a small scale, where the cost of fuel is no item, as waste material is burned. They are largely used in the Joplin, Mo., district, where the hoisting is from vertical shafts 100 ft. deep, the output often only 25 to 50 tons per day, and the ore raised in buckets without guides, thus keeping the dead weight small, as compared with weight of ore raised. They are not adapted for regular mining work on a large scale, as the work expended in raising the cage, car and rope, each trip, would exceed the work of raising the ore.

Double-drum engines overcome the dead-work of hoisting the ore carriers by balancing the weight of the cage and car in one compartment against those in the other. They are thus more economical to operate than a single-drum engine, and the cost of installing will probably not be over 50% greater than for a single-drum engine. As the cost of sinking a shaft large enough for two hoisting compartments, and a manway is not much more than to sink one having only one hoisting compartment and a manway, the head buildings must be nearly the same in either case, and the double-drum engine will have smaller cylinders, which will partly offset the cost of the second drum.

With cylindrical drums, the ropes in the two compartments are of constantly varying lengths from the cages to the head sheaves, and are in balance only when the cages are passing at the center. With double conical drums, the work on the engine is kept constant by giving the cage at the bottom the short leverage of the small end of the drum, and the cage at the top the longer leverage of the large end of the drum.

The Koepe system, as applied to a double compartment shaft, has a tailrope passing from the bottom of one cage down and around an idle sheave at the bottom of the shaft, and up to the other cage. Thus the weight of the rope in the two compartments is exactly equal, and the whole hoisting mechanism is in balance at all points of the trip.

The flat-rope system of hoisting attempts to equalize the work on the engine by coiling a rope of rectangular cross-sections on a reel, like a surveyor's linen tape; so that the diameter of the reel increases and the leverage of the load increases as the weight of the constantly shortening rope decreases. Thus the work of the engine is kept constant, when the rate of increase of leverage and decrease of weight are in inverse proportion to each other. The flat ropes, however, are heavier than round ropes of the same strength, are shorter-lived, and cost more at first and for subsequent care. The flat-rope system is very largely used in Montana, and in some other districts which have followed the Montana practice.

The peculiarities of the different types of engines are brought out more fully by the calculation of the size of their cylinders when equipped with the different arrangements of drums.

CALCULATION OF THE CYLINDERS.—The maximum work on the engine is in picking up the load and in overcoming its inertia. At this time one crank may be on a dead center, so that all the work must be done by the other. At this part of the hoist, steam will be admitted for the full stroke and at its maximum throttle pressure.

Hoisting engines belong to the slow-speed type of engines. Their valves are simple slide-valves in all but the largest sizes, and then they are usually of the Corliss class. They seldom have governing devices, their speed being determined by the hoisting engineer by means of the throttle, the link-motion and the brake.

With these classes of engines the piston-speed may be taken at 200 to 400 ft. per min. for engines of 12 to 24-in. stroke, and from 400 to 600 ft. per min. for those with 24 to 72-in. strokes. Very high-grade engines, with other valve-gearing, may run at higher piston speeds.

At the instant of starting, the power in one cylinder acting on the crank, in the top or bottom position, must have a moment equal to or greater than the moment of the unbalanced load pulling from the circumference of the drum. After starting, the other cylinder comes in to accelerate the speed, and the two together are able to hoist the load with steam partially cut off and still maintain the full speed.

In all the following equations, let

W = weight of unbalanced load in pounds;
C = weight of cage and car in pounds;
O = weigbht of ore in pounds;
D = diameter of drum in feet;
P = M. E. P. = mean effective steam pressure in cylinder in lbs. per sq. in.;
A = area of cylinder in sq. ins.;
L = length of stroke in feet;
S = speed of hoisting in ft. per min.;
N = number of revolutions of engine per min.;
F = friction in pounds;
f = coefficient of friction;
r = ratio of diameter of piston to length of stroke, both being in feet or both in inches $= \frac{\text{stroke}}{\text{diameter}}$.
d = diameter of piston in inches;
e = efficiency of engine;
g = ratio of gearing $= \frac{\text{diameter of gear}}{\text{diameter of pinion}}$.

Then, for a single-drum, direct-acting engine, Fig. 1, the moment of the load $= (W + F)\ \frac{D}{2}$ and the moment of the engine $= (P \times A \times e)\ \frac{L}{2}$, placing these equal to each other.

$$\frac{(W+F)\ D}{2} = \frac{P \times A \times L \times e}{2}. \qquad (4)$$

If the drum is geared, the engine will make g revolutions to one of the drum, or the leverage of the engine is increased to g times what it would be if direct connected, and the equation becomes

$$\frac{(W+F)\ D}{2} = \frac{P \times A \times L \times e \times g}{2}. \qquad (5)$$

This is the general equation for all hoisting engines. If they are direct connected, the ratio of gearing, g = 1.

When the weight of the load, size of the drum, and steam pressure are given to determine the size of the cylinders, there are two unknown quantities in the equation, viz.: A and L. Here L can be assumed and the equation solved for A, from which the diameter can be obtained. The usual practice is so to proportion the cylinder that the length of travel is 1¼ to 2½ times the diameter of the piston. If the value of L chosen for trial gives a ratio of stroke to diameter outside of these limits, another value must be taken for L, and another solution made. If the ratio is decided upon first, then the area can be expressed in terms of the stroke, and there is only one unknown in the equation. Thus

$$r\ d = 12\ L \text{ or } d = \frac{12\ L}{r}$$

(12 L being the length of the stroke in inches), and

$$A = \pi\ \frac{d^2}{4} = \pi\ \frac{144\ L^2}{4\ r^2};$$

which, substituted in equation (5), gives

$$\frac{(W+F)\ D}{2} = P \times \pi\ \frac{144\ L^2}{4\ r^2} \times \frac{L}{2} \times e \times g. \qquad (6)$$

Having obtained the size of cylinders, and knowing the speed of hoisting and size of drum, the speed of the engine can be obtained, and the speed of the piston can be investigated. The speed of hoisting in feet per minute, divided by the circumference in feet, will give the number of revolutions of the drum per minute. If the drum is geared, the engine will make g times as many revolutions per minute as the drum, and

$$N = \frac{S}{\pi\ D}\ g. \qquad (7)$$

The piston speed in ft. per min. $= 2\ L \times N$, or

$$\text{Piston speed} = \frac{2\ L\ S}{\pi\ D}\ g. \qquad (8)$$

Where the engine is direct acting, g = 1 in both equations (7) and (8).

The horse-power available for hoisting when the engine is running at full speed will be expressed by the formula:

$$\text{HP. of engine} = \frac{P \times L \times A \times 2\ N}{33{,}000} \times e. \qquad (9)$$

And the horse-power required to raise the load will be:

$$\text{HP. of load} = \frac{(W + F)\ S}{33{,}000}. \qquad (10)$$

In the examples here given the weight of the car is taken as ⅖, and the weight of the cage as ⅗ of the weight of the ore hoisted. These together make the dead load, C, equal to the weight of the ore, O. These are sufficiently close to the usual practice for an illustration of the method of using the formulas.

As an example, take a double-cylinder engine geared to a single drum under the following known conditions, to find the size of cylinders required: Vertical shaft is 400 ft. deep, cages to be hoisted in 1 min.; the weights are, cage 900 lbs., car 600 lbs., ore 1,500 lbs.; steam pressure, P is 60 lbs., e = 0.7, g = ⁴/₁, f = .01 (assumed), D = 4 ft., and L may be taken as 1½ ft. for a trial solution; then

$$W = C + O + R = (600 + 900) + 1{,}500 + (400 \times 1) = 3{,}400 \text{ lbs.}$$

$$F = W\ f = 34 \text{ lbs.}$$

Substituting in equation (5),

$$(W + F)\ \frac{\frac{D}{2}}{2} = P \times A \times \frac{L}{2} \times e \times g;$$

$$(3{,}400 + 34)\ \frac{\frac{4}{2}}{2} = 60 \times A \times \frac{1\frac{1}{2}}{2} \times 0.7 \times 4;$$

$$A = 54.5;$$

$$d = 2\sqrt{\frac{A}{\pi}} = 8.33; \text{ say } 8\tfrac{1}{2} \text{ ins.}$$

The stroke L was taken as 18 ins. for a trial solution, and it gives a well-proportioned cylinder, viz., 8½ ins. diameter × 18 ins. stroke.

The speed of the piston can be tested by equation (8).

$$\text{Piston speed} = \frac{2\ L\ S}{\pi\ D}\ g = \frac{2 \times 1\frac{1}{2} \times 400 \times 4}{3.1416 \times 4}$$

$$= 382 \text{ ft. per min.,}$$

which is within the limits of these engines.

From equations (9) and (10) combined, the mean effective pressure required in the cylinders to perform the work can be determined. Substituting the known values in these equations, and placing one equal to the other and solving,

$$HP = \frac{(W + F)\ S}{33{,}000} = \frac{P \times L \times A \times 2\ N}{33{,}000} \times e;$$

$$\frac{3{,}434 \times 400}{33{,}000} = P \times {}^{4}/_{2} \times \frac{2 \times 56.75}{33{,}000} \times 2 \times \left[\frac{400 \times 4}{3.1416 \times 4}\right] \times 0.7$$

$$P = 45,$$

which, with 60 lbs. at throttle, corresponds to a cut-off of about ½. As both cylinders are in use, the area has been doubled in the above calculation.

With double-drum hoisters, where the descending cage and car counterbalance the ascending ones, the general equation (5) still applies, but the value of W and F are

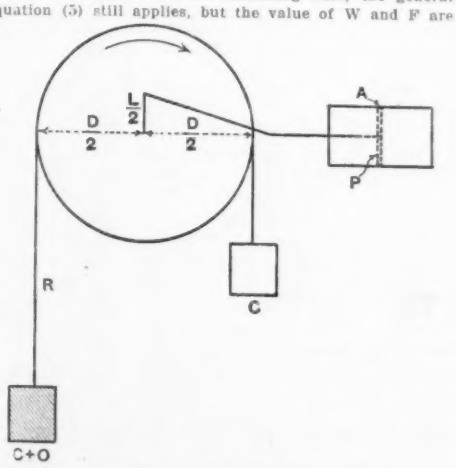


Fig. 2. Double Cylindrical Drum Engine.

changed. Referring to Fig. 2, when a loaded car is to be started from the bottom of the shaft and an empty car is being lowered at the same time,

$$W = (R + C + O) - C = R + O,$$

and

$$F = (R + 2\ C + O)\ f,$$

which values must be used in the first member of equation (5).

As an example, take a hoister raising a load from a double compartment shaft 2,000 ft. deep in 1 min.:

O = 5,000 lbs., R = 6,000 lbs., P = 60 lbs.
C = 5,000 " D = 8 ft.,

engine direct connected; hence

g = 1, f = 0.01, e = 0.7.

Taking L = 4 ft. for a trial and substituting in equation (5) to find the size of cylinders,

$$(W + F)\frac{D}{2} = P \times A \times \frac{L}{2} \times e \times g;$$

$$(11{,}000 + 210)\frac{8}{2} = 60 \times A \times \frac{4}{2} \times 0.7 \times 1;$$

$$A = 534;$$

$$d = 2\sqrt{\frac{A}{\pi}} = 26\tfrac{1}{8} \text{ ins.}$$

This gives a cylinder 26⅛ ins. diameter by 48-in. stroke.

Determining the piston speed by equation,

$$\text{Piston speed} = \frac{2\,L\,S}{\pi\,D}\,g = \frac{2 \times 4 \times 2{,}000 \times 1}{3.1416 \times 8}$$

$$= 637 \text{ ft. per min.}$$

While the proportions of the cylinders follow the usual practice, the piston speed exceeds the limits previously set for this class of engines, viz., 400 to 600 ft. per min. This speed can be reduced by choosing a smaller value for L in equation (5), which will give a cylinder larger in diameter. Thus, if the length had been taken as 44 ins., or L = 3⅔ ft., d would have been 27¼ ins. and the ratio $\frac{12\,L}{d}$ = 1.6 +, and the piston speed = 584 ft. per min.

Or, instead of shortening the stroke, the number of revolutions can be cut down by increasing the diameter of the drum, thus if D = 9 ft., L = 4 ft., d will be 27¾ ins., and the ratio $\frac{12\,L}{d}$ = 1.73 and the piston speed = 566 ft. per min.

Conical drums, as already noted, are intended to equalize the varying load on the engine, due to the change in length and weight of the rope as the cage ascends and descends. As these engines are used where every economy is desirable, they are usually direct-acting and fitted with double drums.

The minimum diameter of the drums is determined by the size of the rope.

Referring to Fig. 3, let D represent the small diameter of the drum in feet;

- v = diameter of large end of drum in feet;
- C = weight of cage and car in pounds;
- O = weight of ore in pounds;
- Rl = weight of the long length of rope when cage is at the bottom of the shaft;
- Rs = weight of the short length of rope when cage is at the top of the shaft.

Then,

$(C + O + Rl)\frac{D}{2} - (C + Rs)\frac{y}{2}$ = moment of the resistance when the load is at the bottom (Fig. 3) position A,

and

$(C + O + Rs)\frac{v}{2} - (C + Rl)\frac{D}{2}$ = moment of the resistance when the load is at the top (Fig. 3), position B.

The object of the conical drums being to keep this moment constant, these two values must be equal, and

$$(C + O + Rl)\,D - (C + Rs)\,y = (C + O + Rs)\,y - (C + Rl)\,D. \qquad (11)$$

Solve for y. Then, taking either end case, say when the load is at the bottom, the moment of the resistance of the loads, with friction added, must equal the moment of the

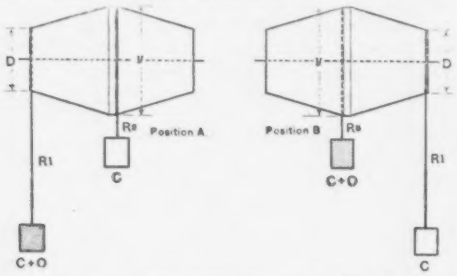


Fig. 3. Double Conical Drum Engine.

power of the engine, and, following the same form as equation (5), gives:

$$(C + O + Rl)(1 + f)\frac{D}{2} - (C + Rs)(1 - f)\frac{y}{2} = P \times A \times \frac{L}{2} \times e \times g. \qquad (12)$$

Taking as an example the one used for the engine with double cylindrical drums, depth 2,000 ft. plus 33⅓ ft. to head sheave above landing,

S	= 2,000 ft. per min.;	P	= 60 lbs.;
O	= 5,000 lbs.;	g	= 1;
C	= 5,000 "	f	= 0.1;
Rl	= 6,100 "	e	= 0.7;
Rs	= 100 "	L	for trial = 4 ft.
D	= 7 ft.;		

to find diameter of cylinder.

From equation (11)

$$(C + O + Rl)\,D - (C + Rs)\,y = (C + O + Rs)\,y - (C + Rl)\,D$$

$$(16{,}100 \times 7) - (5{,}100\,y) = (10{,}100\,y) - (11{,}100 \times 7)$$

y = 12.52 ft. = diameter of large end of drum.

Substituting in equation (12)

$$C + O + Rl = 5{,}000 + 5{,}000 + 6{,}100 = 16{,}100 \text{ lbs.};$$
$$1 + f = 1.01;$$
$$C + Rs = 5{,}000 + 100 = 5{,}100 \text{ lbs.};$$
$$1 - f = 0.99;$$

$$\left[16{,}100 \times 1.01 \times \frac{7}{2}\right] - \left[5{,}100 \times 0.99 \times \frac{12.52}{2}\right] = 60 \times A \times \frac{4}{2} \times 0.7 \times 1;$$

$$56{,}914 - 31{,}607 = 84\,A;$$

$$A = 301;$$

$$d = 2\sqrt{\frac{A}{\pi}} = 19\tfrac{5}{8} \text{ ins.}$$

From equation (8)

$$\text{Piston speed} = \frac{2\,L\,S}{\pi\,D}\,g = \frac{2 \times 4 \times 2{,}000}{\frac{\pi\,(7 + 12.52)}{2}}$$

$$= 522 \text{ ft. per min.}$$

D being taken here as the mean diameter.

There must be a division left between the ropes on a conical drum in order to furnish positive grooves for the rope, so that the large coils cannot slip down over the smaller ones; hence the drum must be longer than those of the cylindrical design, even when the mean diameter of the conical drum is the same as the diameter of a cylindrical one.

In the Koepe system, as applied to a double compartment shaft, there is a tail-rope of the same weight as the hoisting rope, fastened to the bottom of one of the cages, passed around a sheave in a pit at the bottom of the shaft, and attached to the bottom of the other cage. Then, in whatever position the cages are, in the shaft, there is the same weight of rope hanging in each compartment. Thus the entire weight of the hoisting mechanism is in perfect balance at all times, and the engine only has to raise the weight of the ore and overcome the friction of the moving parts. The main rope may be wound on a pair of cylindrical drums, or it can be wrapped back and forth over a pair of multiple-grooved sheaves, as is done in rope drives for many purposes. It is essential that a positive grip is taken on the rope by the driving mechanism, or else its creeping on the driving sheaves will make the indicators show a false position for the cages, and make accidents of overwinding a great source of danger.

The calculation of the size of the engines required can be made by equation (5). The engines would usually be direct acting.

As an example, assume the same conditions as have been used before:

S	= 2,000 ft. per min.;	e	= 0.7;
O	= 5,000 lbs.;	f	= 0.01;
C	= 5,000 "	g	= 1;
R	= 6,000 "	D	= 8 ft.;
P	= 60 lbs.;	L	= 4 ft., for trial.

$$(W + F)\frac{D}{2} = P \times A \times \frac{L}{2} \times e \times g. \qquad (5)$$

$W = O = 5{,}000$ lbs ; $F = f\,(O + 2C + 2R) = 0.01 \times 27{,}000 = 270.$

$$(5{,}000 + 270)\frac{8}{2} = 60 \times A \times \frac{4}{2} \times 0.7 \times 1;$$

$$A = 251;$$

$$d = 2\sqrt{\frac{A}{\pi}} = 18 \text{ ins.}$$

This is rather a small diameter for a cylinder of this length, as its length is 2⅔ times the diameter, which exceeds the ratio already recommended. If L were taken as 36 ins., the area would be 335 sq. ins., corresponding to 20⅝ ins. diameter, which gives a cylinder with better proportions.

The piston speed can be obtained from equation (8), and the mean effective pressure required, when hoisting at full speed, can be found from equations (9) and (10) combined.

It is interesting to compare the size of the three types of engines, hoisting the same load at the same speed. These tabulated are:

Type.	Diameter of drum.	$(W + F)\frac{D}{2}$.	Diameter of cylinder.
Cylindrical drums ...	9.76	59,198	29
Conical drums	9.76	24,669	19⅝
Koepe system	9.76	25,727	19¾

The conditions in all of the above were the same as used in former examples, except that the diameters of drums are all taken as 9.76 ft., which is the mean diameter of the conical drums. The engines are direct-acting, the shaft has double compartments, and the cages work in balance.

C	= 5,000 lbs.;	f	= 0.01;
O	= 5,000 "	e	= 0.7;
R	= 6,100 "	g	= 1;
P	= 60 lbs;	S	= 2,000 ft.
L	= 4 ft.;		

The piston speed is 522 ft. per min. in each case.

The table shows that cylindrical drums are not as economical to operate as either the conical drums or the Koepe system. The conical drums are expensive to make as the grooves have to be formed spirally and with an increasing radius, and each problem requires a specially designed drum, so there can be little use made of stock patterns. They are only used where the rope is heavy, and the economy of accurate counterbalancing is clearly indicated, and will offset the extra cost of manufacture.

The Koepe system is a simple method of counterbalancing, and the principle could often be applied to existing plants with cylindrical drums by adding a tail rope and an idle sheave at the bottom of the shaft, provided there is sufficient suitable room for the sheave and its slide. The objection to the Koepe system, where used without drums, is the liability of the ropes to creep on the sheaves, causing the indicators to give a false record and to increase the danger of overwinding.

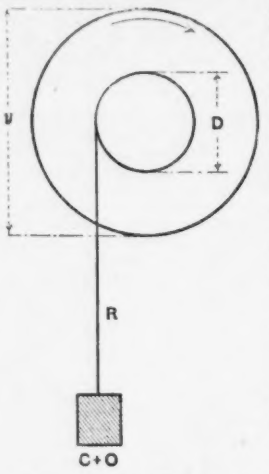


Fig. 4. Flat Rope Reel.

Flat ropes of rectangular cross-section are wound on a reel like a tape. When the load starts from the bottom of the shaft the rope winds on the center of the reel, which is of small diameter, and then, as the load rises, the successive layers increase the diameter of the coil on the reel; thus the leverage of the load increases and the weight decreases. If the original diameter of the barrel of the reel and the thickness of the rope are properly chosen, the moment of the resistance will be constant.

The proportions of the reel can be found as follows:

Let

- D = diameter of the barrel in feet;
- y = diameter of coil of rope, when cage is at the top, in feet;
- C = weight of cage and car; O = weight of ore, and R = weight of rope—all in pounds, as before;
- l = length of rope or depth of shaft in feet;
- t = thickness of rope in inches;
- n = number of layers of rope in coil.

Then, referring to Fig. 4,

$$\frac{y + D}{2}\,\pi \times n = l, \text{ and } \frac{(y - D)\,12}{2\,t} = n.$$

Substituting the latter value of n in the first equation gives

$$\frac{y + D}{2}\,\pi \times \frac{(y - D)\,12}{2\,t} = l.$$

$$(y^2 - D^2)\frac{3\,\pi}{t} = l. \qquad (13)$$

From equation (13), knowing t, the value of y can be obtained, or having decided on y, the equation can be solved for t. The minimum diameter of the barrel D depends on the thickness of the rope, and can be calculated from Mr. Hewitt's equation previously given:

$$k = \frac{E\,a}{\frac{R}{2.06\,\frac{}{d}} + C},$$

in which

- k = bending stress in pounds;
- E = modulus of elasticity = 28,500,000;
- a = aggregate area of the wire in sq. ins.;
- R = radius of the bend in inches;
- d = diameter of individual wires, and C a constant depending on the number of wires in a strand.

With a flat rope, d = ⅛ the thickness of the rope, and C = 27.54.

The moment of the resistance at starting the load would be the moment of the weight, C + O + R + the friction, acting with the lever arm $\frac{D}{2}$, as by equation (5).

The ideal case would be one in which the work of hoisting was constant at every part of the hoist; but the thickness of the rope may be such that the leverage of the load increases faster or slower than the weight of the load decreases, thus making the work on the engine to vary during the trip. In such a case, the design must be tested with the case at various points, to make sure that the engine has sufficient power to handle the loads at the desired speed at all points. For this, equations (9) and (10) may be used.

Generally these hoists are arranged in pairs, so that one cage ascends while the other descends. Then the necessary large diameter of the reel, to make the work constant on the engine, can be found by equation (11), used for conical drums, and the size of the engine from equation (12). After which the thickness of the rope can be found by equation (13).

If the reels cannot be made of such diameter, with a reasonable thickness of rope, as to make the work of hoisting uniform throughout the trip, then the case must be considered by itself, and the design must be tested with the cage in positions sufficiently numerous to prove that the engine that will start the load is strong enough to handle it at all points.

ELECTRIC DRIVING IN A BELGIAN STEEL MILL.

Some interesting features distinguish the power equipment of a large furnace and mill plant now being erected near Antwerp, Belgium, by the Antwerp Iron & Steel Works. The works are planned to comprise a blast furnace, steel furnaces, a rolling mill for structural shapes, sheets and plates, a boiler shop and a foundry. By-product coke ovens are included in the plant, and it is probable that a briquette-fuel factory and a slag-cement factory will also be constructed. As may be gathered from this, the complete plant covers a considerable ground area; to provide power for the various uses required over the entire works, it was decided to adopt a complete electric system, the power being generated in a works central station and utilized by motors attached to the different machines. This electrical system employs polyphase alternating current exclusively. It should be specially noted as novel that the rolling mills are driven by electric motors, two of the roll-sets having their motors direct-connected to the main roll-shaft.

This is an interesting new application of electric driving, and we therefore give in the following a few particulars of the power equipment of the rolling mills; these data were kindly furnished us by Mr. G. A. Wardlaw, of the Westinghouse Electric & Mfg. Co., to whom we are also indebted for the accompanying illustrations.

The steel mill of the plant comprises three sets of rolls, one roughing or blooming mill, of two stands, and two finishing mills, three-high, of five stands each; the latter mills take each the output from one of the stands of the roughing mill. The blooming mill has 24-in. rolls, running at 70 r. p. m. The driving motor is belted to this mill; it is a three-phase induction motor of 325-HP. capacity, operating under a pressure of 2,150 volts on a circuit of 6,000 alternations per minute. The normal speed of the motor is 300 r. p. m., and by means of a controller the speed can be reduced about 25% without any reduction of the full-load torque. A heavy flywheel, weighing about 30 tons, is provided for the blooming mill to smooth out the variations in demand on the motor. This mill, it may be stated, is designed to handle 450-lb. and 880-lb. ingots, one stand taking the smaller billet, and the other the larger.

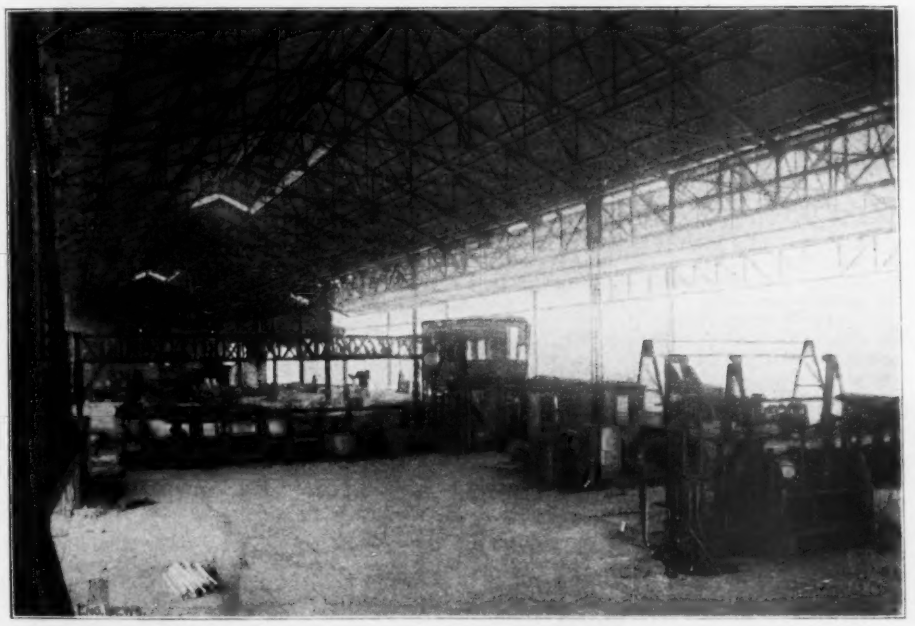


FIG. 1. VIEW OF ELECTRICALLY-DRIVEN ROLLING MILLS AT THE PLANT OF THE ANTWERP IRON & STEEL WORKS, ANTWERP, BELGIUM.

The accompanying view, Fig. 1, shows the interior of the rolling-mill building, with the roll-stands in the foreground. The blooming mill, just spoken of, is at the extreme right of the foreground, while located some distance back are the two sets of finishing rolls. In the center between the two latter mills a small wooden structure will be seen. This little house encloses two motors which drive the finishing rolls. A short distance back of this motor house is a switchboard, elevated on a platform; this board controls the entire electric equipment, both power and lighting, in the rolling-mill building.

The finishing-mill drive consists of one three-phase induction motor for each of the two mills; like the one already described, these motors take current at 2,150 volts and 6,000 alternations—the regular works distribution current. The one mill has 14-in. rolls, and is designed to take 3¼-in. blooms (rolled from 880-lb. billets) from the roughing mill; its motor is of 450-HP. capacity. The motor and the main roll-shaft are directly connected by a bolted flange coupling, and on the roll-shaft, just outside the motor house, is mounted a flywheel of about 12 tons weight. The other mill has 10½-in. rolls, and works a 2¾-in. bloom, a 450-lb. billet being reduced to this size in the roughing mill. The driving motor of the 10½-in. mill is of the same type as the others, but only of 325 HP.; its connection to the rolls is, as in the opposite finishing mill, by solid flange coupling, and a similar flywheel is provided on the roll-shaft.

The method of controlling the rolling-mill motors is rheostatic adjustment of the rotor resistance. Each motor has a controller of the railway type; this contains a main reversing switch for the primary circuit and appropriate contacts for throwing resistances into the secondary circuit. The secondary resistances are thrown in on the three sections of the rotor circuit by three separate drums. The resistances themselves are of iron, and are arranged to give 15 steps of reduction. The rolling mills have been in operation now for some time, and it is said that the working of their electric drive is fully satisfactory.

A few words regarding the central generating and distributing arrangement of the plant may not be out of place. It is estimated that the complete works as planned will require a maximum of 30,000 HP. Eventually the waste gases from the blast furnace will be utilized as a source of part of this power. At present there are two main steam engines, each a triple-expansion marine engine of 1,500 HP,, running at 187 r. p. m. These engines were originally installed on an English torpedo boat, but have been reconstructed for their present service. The main generators, direct-connected to the engines, are 900-KW., three-phase alternators, with rotating field, generating current at 2,200 volts, 6,000 alternations. A third generating set is also in use: a 400-KW. three-phase alternator, with rotating armature, is driven by belt from the main engines. It is intended later to drive this generator by an 800-HP. tandem-compound gas engine. Two exciters complete the plant. Each comprises a 58-HP. compound engine of the Westinghouse type, running at 350 r. p. m., and direct-connected to a 25-KW. multipolar 220-volt generator.

The central station switchboard is provided with two sets of high-tension bus bars; one set supplies current exclusively to the rolling-mill motors above described, and thus this circuit with its great fluctuations in load is kept separate from the other supply circuits. The switchboard has six panels: one exciter panel, two generator panels, one rolling-mill panel, one lighting panel, and one panel for the power circuit supplying the boiler shop, the foundry and the repair shop. Transformer substations are arranged at different parts of the plant to supply the various lighting and power circuits. It may be noted that the rolling-mill motors are the only ones operating at the full line-pressure, 2,200 volts at the generator.

Fig. 2. Elevated Water Tank at the Plant of the Antwerp Iron & Steel Works.

The entire electrical equipment was furnished by the Westinghouse Electric & Mfg. Co., and is of the standard Westinghouse construction throughout. The contract was secured against the competition of the leading European electrical manufacturers.

In connection with the preceding, the illustration, Fig. 2, may be of interest. It shows an elevated water tank standing just outside the central power station. The dove-cote housing and ornamentation of the tank and its supporting standard are to our eyes rather curious, but fairly represent a quite prevalent tendency in Continental Europe to æstheticize prominent engineering structures.

SIGNALS FOR URBAN AND INTERURBAN RAILWAYS.*

By G. W. Palmer, Jr.†

The many recent disastrous collisions on street railways must have convinced operators and managers that the use o fan efficient and reliable signal system would add to the safety and facility of the handling of their traffic. As faster schedules and heavier cars come into use, there is imperative need of a system of operation which will guarantee freedom from accidents caused by cars meeting or overtaking one another.

There is only one way to prevent these accidents, namely, to adopt such rules and methods of operation as

*Abstract of a paper read at the annual convention of the American Street Railway Association at Detroit, Oct. 8 to 10.

†Old Colony St. Ry. Co., Boston, Mass.

will insure that but a single car will occupy any block or section of track at any time; any signal system which will aid in accomplishing this result is worthy of consideration.

The signals used on steam railways are now probably as nearly perfect as human skill and ingenuity can make them. They did not, however, spring into existence in their present perfect condition, and electric roads should not, therefore, say, "show us a perfect system and we will adopt it."

It is obvious, however, that even a perfect signal system cannot, after its adoption and installation, operate a road. Careful management and good discipline on the part of the men are still vitally necessary. We believe that no man should be given a second opportunity to disregard a signal set against him or to break any rule which it has been found necessary to make to insure safe operation.

All single track suburban and interurban roads should adopt the best obtainable block system, together with a telephone system, which will enable a dispatcher to reach any car crew at regularly established stations.

A signal to be reliable and efficient, should be quick and positive in action; it should be impossible to set the cautionary or permissive signal at near end of the block before setting the danger indication at the far end; incandescent lamps should not form a part of the main signal circuit, nor should the lighting and extinguishing of lamps be the only visual indication of the signal. This should be supplemented by the movement of an arm or semaphore blade, which will move each time the signal is operated, whether the lamps burn or not. The device will then be operative if the lamps burn out, as sometimes will happen. Manual control affords unauthorized persons a chance to interfere with the signal, and should not be used; the setting and clearing circuits should be closed automatically, and when the signal has been set at danger it should lock so that it cannot be cleared until all cars have passed out of the block. It should be possible to set the signal only one way by two cars entering a block from both ends at the same time.

Special attention should be given to freedom from damage by lightning. As the pressure is liable to fall considerably at the ends of long lines, and also on parts of the system when heavy local loads are carried, the signal should be able to operate through a wide range of voltage, and should not be liable to damage through crossing of the signal circuit with the lines.

There are several differing systems now in use on various roads; one using simply a circuit of lamps operated by a two-way hand switch at either end of the block, part of the lamps being lit as a permissive signal at the near end, while the balance indicates danger to an approaching car at the far end. This system is peculiarly susceptible to trouble from lightning, and also fails when any lamp burns out. As commonly used, the switch and lamps are in the same box, and generally the car is run into a position where the conductor can easily reach the switch. In most cases the motorman then cannot see the lamps, and depends on the bell signal from the conductor.

The proper method would be for the car to be stopped at a point far enough to the rear of the box for the motorman and passengers to observe the character of the signal, the conductor going ahead and throwing the switch. Where the blocks are many, this will cause an annoying delay, which could be avoided by having the switch separate from the signal box, at a point about 100 ft. to the rear of it, and at such a height that the switch cannot be reached from the ground. When permission to proceed has been obtained, the motorman should not enter the block until the conductor has struck two bells, thus making the men jointly responsible. An improved method of operating the signal is by means of a circuit closer hung overhead and at a point sufficiently in the rear of the box, the circuit being closed by the passage of the trolley wheel; there are devices of this kind now obtainable which are reliable and effective in action.

A better system is one which uses a setting and clearing circuit separate from the lamp or semaphore circuit. Most of these, however, can be cleared by the passage of any one car out of the block, and in case of running several cars together, all trolleys but the one on the rear car must be pulled down when passing the switch, or if the leading car clears the block, the car proceeding in the other direction must be notified of the number of cars following; this is an element of danger, as it should be absolutely impossible to clear a block while any car remains. Some device should be used which will record the number of cars entering the block from either end, and hold the setting circuit closed until all cars have passed off the block. It should also be possible to clear the danger signal from both ends of the block, as it is often necessary for a car to leave a block from the same end at which it entered.

There are certain single track blocks on the Old Colony St. Ry. system which are operated by means of what is locally known as the "red stick." This is a small club or billet of wood painted red, which controls the block to which it belongs, and no car is allowed to enter the block without it carries the "red stick," it being replaced by a red lantern at night. This is a safe but not very flexible system, the absence of the stick showing that there is a car on the block, but not the direction in which it is going. Nor does it show when the block is cleared from the other end. In case of delay or blockade of cars going in the opposite direction the stick could not be carried back and all cars going in the same direction as the one which first entered the block would be held up. It does prevent effectually the "bunching" of cars at one end of the line.

Double track roads are also feeling the need of some system which will prevent rear end collisions. Where cars are operated on quick headway and a direct view of the track ahead cannot be had, there is always danger of a car overtaking the preceding one. This is particularly the case at night, and all cars operated on suburban lines should carry a rear end red lantern. This simple precaution is so obvious that it would seem as though it must have been adopted by every one. Such, however, is not the case.

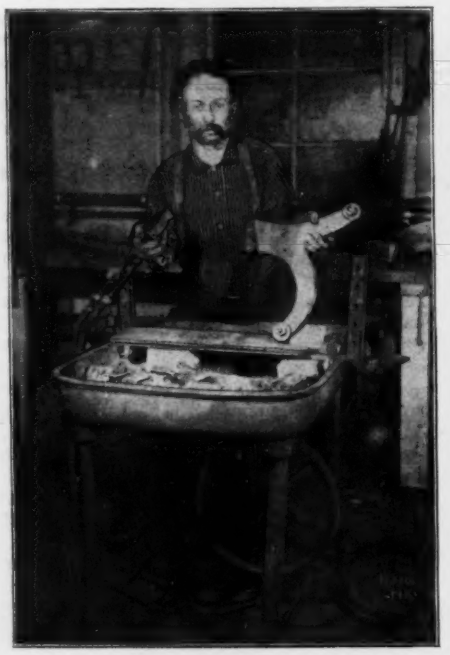


Fig. 1. Forge and Torch Used in Brazing a Broken Casting.

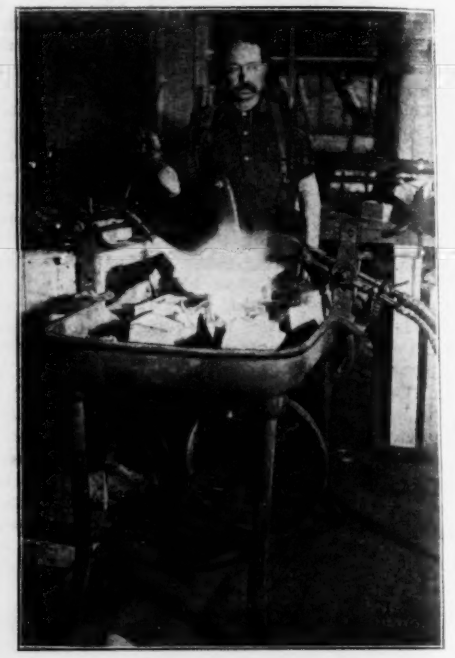


Fig. 2. Brazing a Casting, Using Two Torches

There has been some work done along the line of cutting off the trolley current from a car which has not the right of way, thereby making it impossible for the car to proceed. This scheme seems to be a very attractive one and it is possible that it may be effectively developed.

Too much stress cannot be laid on the necessity of giving careful attention to the proper erection and maintenance of the signal lines and devices. In regard to the lines, their maintenance is more difficult with us than with the steam roads. We are forced to carry many of our wires in streets lined with thick and heavy trees, through which it seems almost impossible to obtain good and reliable construction. In all cases special attention should be paid to keeping the wires clear from the limbs and a tough and impervious insulation should be used. Regular and careful inspections of all parts of the system should be made, and everything done which may be necessary to keep it at all times in the best of condition.

BRAZING CAST IRON BY A NEW PROCESS.

About four months ago the first shop in the United States for the brazing of cast iron was opened, and it is therefore probable that few of our readers are aware that cast-iron brazing is a possibility. The difficulty in brazing cast iron hitherto appears to have been due to the presence of the graphitic carbon in the cast iron, which prevented the adherence of the brass spelter to the iron. To overcome this difficulty it was necessary to devise a process whereby the excess of carbon could be removed for a depth of 1-16 to 1-8-in. back of the surfaces to be united by brazing. This has been successfully accomplished by a process upon which letters patent have been granted to Friedrich Pich.

The numbers and dates of patents are as follows: Nos. 647,631 and 647,632, Apr. 17, 1900, and No. 688,030, Dec. 3, 1901.

The American Brazing Co., with its offices at 136 South 4th St., Philadelphia, and its shops at 532 West 22d St., New York city, controls the patents and sells shop rights; it also does custom work in brazing. We are informed that the process has been in use for over a year by Krupp in Germany, and also by the firm of Siemens & Halske.

THE PROCESS OF BRAZING.—In order to successfully braze cast iron it is essential that the surfaces be perfectly clean and bright. To accomplish this, any oil upon the surfaces is first burned off and muriatic acid is applied to remove rust. Then the surface is scrubbed with a steel brush until clean and bright, and the casting is allowed to cool. Next a purplish brown decarbonizing powder consisting of suboxide of copper and borax, and known as "ferrofix," is mixed with a liquid to a creamy consistency and applied with a brush to the metal surfaces to be united. The two pieces of cast iron to be brazed are then wired together, lined up, and supported ready for the blast from the "torches." (See Fig. 1.)

The blast is turned on until the casting is brought to a medium cherry red before applying the flux, which is ordinary borax, or preferably a composition known as "borofix;" and flux is continually added until the iron is a light cherry red, when it is ready for the brass spelter. The best grade of spelter known as "medium granulated" is used and is mixed with flux in proportion of one of flux to five of spelter. The heat is kept up and spelter added until it begins to flow out of the bottom of the joint or crack that is being brazed, when the blast is turned off and the casting is allowed to cool slowly in the air. More spelter is laid on top of the casting so as to insure thorough filling of the crack during the cooling. It is stated that any small casting that one man can carry can be cleaned and brazed in an hour's time. At the time a member of our editorial staff visited the company's shop, the largest piece of completed work on hand was an ordinary bench vise, one jaw of which had been broken off and brazed together, the area of the cracked section being about $2\frac{1}{2} \times 3\frac{1}{2}$ ins. It was stated, however, that sections as large as $\frac{1}{2} \times 18$ ins., and 6×10 ins., had been brazed in the shop, and that the company had just contracted to braze the spokes of a ten-ton segment of a 50-ton flywheel for the Jessup Steel Co., the cross-section of the spokes being like that of an I-beam of some 16 ins. depth. Occasionally, as in the case of the spokes of this flywheel, the casting is sprung out of shape, in which case it becomes necessary to spring it back to shape if possible before brazing. An open joint greater than $\frac{1}{8}$-in. in width cannot be brazed.

It sometimes happens that a casting is either

too long or too short to perform its function well, in which case it is possible to crack it across and insert or remove a piece, and braze it together again. A complete piece of repair work of this kind was seen at the shop.

Again, it may happen that a casting is very thin, and after breaking needs reinforcement to prevent a similar accident. In such a case one or more pieces of steel may be brazed to the sides of the casting. A sample of this kind of repair

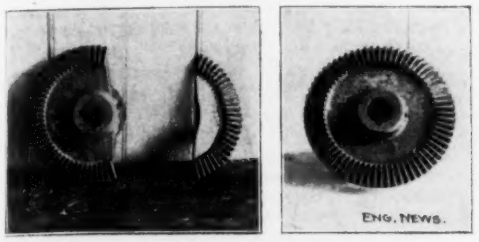


Fig. 3. Small Cast Bevel-Gear Wheel Before and After Brazing.

work was also seen. It has been suggested that where castings are made in two parts to be afterward bolted together, they might be more efficiently fastened by brazing; or, where the shape of the casting is such as to make it difficult to cast in one piece well, the pattern might be cut in two, and the castings afterward united by brazing.

THE FORGE.—Our illustrations, Figs. 1 and 2, show the forge in use at the New York shop. Gas is used for fuel, and air under pressure is fed into the "torch" so as to produce complete combustion at very high temperature. Where neither illuminating nor natural gas is available, the company supplies an oil-burning forge, so that all that is needed besides is an air-blower and power to run it.

FIELD FOR THE PROCESS.—Some of the uses to which this cast-iron brazing process is applicable have been already suggested, and the accompanying photographic illustrations, Figs. 3 and 4, will suggest others. It will certainly find a wide field of usefulness for small castings, and the possibilities of its development make it probable that very large sections may be successfully brazed. It should, perhaps, have been stated above that a casting that is merely cracked part way through cannot well be brazed for two reasons: first, because it cannot be heated without the lia-

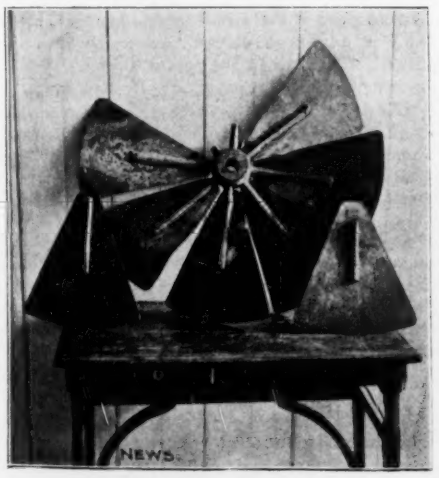


Fig. 4. Broken Spokes of Electric Fan Subsequently Brazed.

bility of the crack opening still more, which may sometimes be prevented by drilling a small hole through the casting at the end of the crack; and second, because the rust cannot be successfully removed from a cracked casting. It is probable, however, that in time means will be discovered whereby the rust may be removed from such a cracked joint. At present, the best way appears to be the reinforcement of the cracked piece by brazing plates of steel to the casting.

The process seems to be of special applicability wherever manufacture or mining is carried on at points far removed from machine shops or foundries, or at any place where it is desirable to repair a broken part of a machine in haste in order to avoid long shutting down of that part of the plant affected by the break.

For the courtesy that has enabled us to secure so complete a description of this cast-iron brazing process, we are indebted to Mr. Wm. S. Haines, Vice-President of the American Brazing Co., and Mr. W. B. Sheppard, General Manager of its New York shops.

ANNUAL CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION.

The 21st annual convention of this association was held at Detroit, Mich., Oct. 8, 9 and 10. The place of meeting was the Light Guard Armory, the main hall of which was also fitted up to accommodate the very extensive exhibits. The opening meeting was called to order about 11 a. m. Oct. 8, and the Mayor, Mr. W. C. Maybury, delivered an address of welcome, which was responded to by the President, Mr. H. H. Vreeland, President of the Metropolitan Street Railway Co., of New York. Mr. Vreeland then delivered the annual address, in which he discussed some very important matters, and an abstract of this address is given below:

PRESIDENT'S ADDRESS.

The greatest development in electric railway work since our last convention, and, in fact, for several years has been in the direction of interurban electric railways. The interurban railways have long since passed the stage when they could be considered simply as suburban extensions of city lines. They are doing a through business, which is constantly growing, and the later and more ambitious examples of roads of this class are built with a track construction inferior in no respect to the best practice of steam railways. They operate usually for the greatest part of their distance over private rights of way, and attain speeds which enable them to compete successfully with their steam railway rivals for nearly every class of traffic except long-distance passenger and freight business. This extension of the electric railway has introduced new problems of discussion, such as fares, transportation of freight, etc., into the operating department, as well as the exercise of the most advanced electrical engineering methods, not only in the transmission of the power at high voltage necessary to operate the cars, but in the car equipment as well. Up to the present, direct current has been used on the trolley wire or third rail, but if the experiments with single-phase motors, which it is announced are soon to be tried, prove successful, the possibility of the direct application of alternating current to railway work will remove some of the inconveniences which now exist in the present system.

It is interesting in passing to note that 11 years ago there were about 1,800 miles of electric railways in the country, while to-day there are nearly 25,000 miles; and that against an investment 11 years ago in street railways of about $75,000,000, the total capital invested to-day is in the neighborhood of $2,000,000,000.

We represent a class of corporations which is more intimately related than any other to the comfort, convenience and success of the people who live in cities and towns. It is true that what we are operating is a valuable privilege granted by the public, but its value depends chiefly upon the sufficiency with which the public is served, and the public was moved to grant it solely from considerations of its own comfort and interest. The contract between the public and the street railroads, therefore, is a contract of partnership and the interest of the partners is identical.

And yet, despite this close association of interest, it is the experience of all of us that there is scarcely any limit to the impositions which the public will permit, and rather cheerfully permit, to be laid upon street railway corporations. Legislatures and boards of aldermen seem to regard street railways as fair game to be hit as often and as viciously as anybody chooses.

If, in recent years, street railway shares have been especially good income earners, it is because the street railway companies are meeting the public ends for which they were organized, because they have studied and facilitated the public interests and needs, because they have put themselves in advance of the development of the cities and towns they run through, because at vast expense they have introduced new methods, new machinery, swifter, more frequent and improved accommodations, and it has never been laid down by the courts that a contract could be broken and new conditions imposed because either of the parties to it had done better than was anticipated, and certainly not because both had. And yet the contracts between the public and the street railway companies are being continually infringed upon by the imposition of new taxes and new requirements, and it has come to be considered almost an impertinence for a corporation so injured to offer ever so mild a protect.

The failure to assert rights when they are threatened is always taken as a confession that they do not exist, and encroachment follows encroachment with ruthless certainty. Timid counsels have so far prevailed among the street railway companies in the adjustment of their affairs with the public that in many States there is a gross discrimination in the taxing laws against such corporations. An income tax upon the earnings of corporations is found upon the statute books of many of our American commonwealths; and corporations with which a State has made definite contracts fixing and limiting the obligations on either side are required, notwithstanding these contracts, to pay other and additional taxes upon their gross earnings.

The rule that there can be no impairment of the obligations of a contract is to be found in the fundamental law of the United States and of every State. In controversies between individuals no constitutional guarantee is more carefully protected by the courts, and in a contract between the State and a corporation there is no trouble about holding the corporation. If it violates its contracts, or if it does not give the promised service or duly make the promised payments, the attorney-general is authorized to institute proceedings for its dissolution. But the rule of performance does not work both ways. It appears to bind only the corporation. The State can pass new laws imposing new conditions and the corporation will have its pains for its protest.

I have already referred to the immense mileage of interurban electric railways which has been built during the last few years, especially in the middle west. Many of these roads are hauling freight, and it is a matter of great importance, not only to these roads themselves, but to the cities and towns which they serve, that the facilities which they should enjoy as regards the interchange of freight with the steam railways should be as free as those between the steam railways themselves. The first point requisite to this end is to have convenient connections with the neighboring steam railways, so that the freight cars can be passed from one to the other. The right of the electric company to demand this has recently been decided in New York State in a case which was contested between the Hudson Valley Ry. Co. and the Boston & Maine R. R. Co., in which the Court of Appeals reversed the decision of the Appellate Division and decided that an intersection and connection of the electric road and the steam road should be made in the interests of the local shippers. This right should be of great advantage to the electric railway company, but the full benefit to the local shippers will not be derived until the full privileges of an interchange of freight cars between the two systems shall be as universally recognized as they now are between steam railways, so that freight can originate on either the steam or electric road. Heretofore, in many cases, the steam railway companies have shown an unwillingness to interchange freight with the competing electric roads, on the plea that the latter were not responsible in the same degree as the steam railways, and by this means considerable freight transportation has been diverted from the electric railways.

While it may appear inadvisable to change the name of the American Street Railway Association to accord with the broader field of electric railway service in which many of its members are engaged, it should be understood that the association is not merely a street railway organization, but its scope covers the entire field of electric railway transportation. More than this, it may seem desirable to welcome the participation of all companies engaged in electric railway transportation, for the reason that there is no organization in the country which has accomplished so much, or at its annual conventions and exhibitions can afford anywhere near the same opportunity for instruction to those interested in electric transportation in its different phases. Heretofore no manager or engineer of a trunk line company which is contemplating or has installed a system of electric traction could join this association except as a representative of some street railway company; but in view of the interest which is being taken in electric railway equipment by some of the large trunk line interests and the undeniable future which electric power will have for such transportation, especially for terminal and suburban work, the question will arise in the near future, if it has not already done so, whether the benefits which this association can confer are available for companies which are not now eligible to membership.

The report of the Executive Committee and the Secretary and Treasurer were then read. The latter showed a membership of 191 companies, and a cash balance of $9,948 to the credit of the association. The report of the committee on memorials of deceased members was also presented.

The first paper presented was by Mr. C. D. Meneely, Secretary and Treasurer of the Brooklyn Heights Ry., Brooklyn, N. Y., on

THE REGISTRATION OF TRANSFERS BY CAR CONDUCTORS.

The author considered that transfer tickets should be registered in the same way as cash fares, but upon a single register for both. The

force of his arguments was lessened by a somewhat lengthy description of a proposed lottery system in connection with transfer tickets, to ensure the return of tickets, but it was admitted that this would conflict with the existing laws concerning lotteries.

Mr. Root (Metropolitan St. Ry., New York) opposed registration for a city service where a large proportion of the traffic consists of short rides, but he approved of it for suburban and interurban lines on which passengers ride long distances. Mr. Sloan (Calumet El. St. Ry., Chicago) uses a double register, while Mr. Connett (Syracuse, N. Y.) prefers a single register; in both cases there are systems for checking the transfers. Mr. Beggs (Milwaukee El. Ry. & Light Co.) uses a single register with two dials, and finds that the attention which passengers pay to the register serves as a check upon the men. Mr. N. H. Heft (Elec. Dept., N. Y., N. H. & H. R. R.) uses a duplex transfer system; the delivering conductor sending in one part and the receiving conductor sending in the other part to the auditor's office, where they are checked. There was considerable difficulty in starting any discussion on this paper, but when the ice had once been broken the discussion continued readily until the time for adjournment.

At the afternoon session, a paper on the mutual benefit association of the Metropolitan St. Ry. Co., of New York, was read by Mr. Oren Root, Jr. This he supplemented by remarks on the pension system of the same company, which we incorporate in the following abstract of the paper:

MUTUAL BENEFIT ASSOCIATION AND PENSION SYSTEM.

A street surface railway in a growing community is in the class where assessment insurance can be, so far as the beneficiaries are concerned, profitably applied, and this is evidenced by the Metropolitan Street Railway Association of New York. This association was organized in 1897 by the employees of the company at their own suggestion, and was so planned that any employee between the ages of 21 and 45, who had been in the service of the company three months, was eligible for membership upon the payment of an initiation fee of $1 and dues of 50 cts. per month.

In return for these payments, the association guarantees to its members: 1, in sickness, the payment of $1 a day for a period not exceeding 90 days in any one year; 2, in case of death, the payment of $300 to any beneficiary named by the insured; 3, the free service of a physician who devotes his entire time to the members of the association; 4, the use of reading rooms and a library; 5, use of ten pool tables, for which 1 ct. per cue is charged; 6, free monthly lectures and entertainments during the winter; 7, eligibility for pension under the pension regulations of the company. The association started with 30 members and to-day it has a membership of over 4,500. It is operated with absolutely no expense beyond the stipulated salary of a physician, as all the officers are officers of the company and their services are given gratuitously.

The success of the association is primarily due, not so much to its sound economic features as to the personal relationship established and maintained between the responsible head of the railway company and its employees.

The benefits arising from associations of this kind may be divided into two classes: 1, those derived by the employees, and 2, those derived by the employer. The employees who are retired under the pension system which has been adopted may be divided into two classes: 1, all those who are 70 years of age and who have been 25 years in the service of the company; 2, all those of the age of 65 to 69 (inclusive) who have been 25 years in the service of the company. All those employees who are 70 years of age are retired by the age limit itself. That is compulsory. All those between 65 and 69 are retired at the discretion of the trustees of the pension fund, if they are found in the opinion of the trustees to be incapacitated for active work. If service has been in the company for 35 years or more, these retiring employees are paid at the rate of 40% of their annual average wage for the previous ten years. If 30 years, they are paid 30%, and if their service has been 25 years, they are paid 25% of their annual average wage for the previous ten years. This fund from which each of these allowances are made is appropriated solely by the company and the employees contribute in no way to it.

The discussion on this paper turned largely on the financial arrangements of the pension system, in order to insure permanent capacity to meet the payments.

On motion of Mr. Lang (Toledo Ry. & Light Co.) an invitation was extended to Prof. Goldsborough, of the Transportation and Electricity Department of the Louisiana Purchase Exhibition, to explain the plans of the department in regard to the street railway interests and industries.

A paper on "Express and Parcel Freight Service on Electric Railways" was then read by Mr. G. W. Parker, General Express Agent of the Detroit United Ry. This paper described in much detail the methods which Mr. Parker has developed for the prompt and economical handling of the express traffic on his system. This traffic has assumed very large proportions and is cared for largely in special express cars. The lines tap a farming district tributary to Detroit, and milk was the first commodity to be handled. A convenieht method of handling this traffic has been found to be by the sale of milk tickets, one for each can. Baggage is carried at a uniform rate of 25 cts. per piece, and joint arrangements are made with a transfer company for handling the baggage direct to or from hotels or residences. A parcel express service is also maintained by which parcels weighing 1 to 50 lbs. are carried to any point within a radius of 40 miles for 15 cts., and for 25 cts. to points beyond the 40-mile radius. Delivery from the electric railway station to destination at either end is an additional charge.

Unfortunately there was practically no discussion of this important subject, although the President sought to start it by briefly outlining the system in New York, where an independent express company has a contract to operate its cars on the tracks of the street railway company, paying to the latter a percentage of the receipts. The meeting then adjourned.

On the second day of the convention, no meeting was held, the entire day being set aside for the examination of the exhibits.

STANDARD RULES FOR EMPLOYEES.

The first business on Friday was the report of the Committee on Standard Rules for the Government of Employees, which consisted of a code of rules, making a pamphlet of about 28 pages. The rules were not adopted, but the committee was continued, after Mr. Beggs (Milwaukee Electric Light & Ry. Co.) had made some severe criticisms of certain rules, which he declared could not possibly be carried out on city railways, although they might be practicable for interurban lines.

STANDARDS.

The report of the Committee on Standards was then presented by Mr. N. H. Heft (N. Y., N. H. & H. R. R.). This recommended the use of the T-rail as most desirable for all purposes, and for use wherever the necessary consent can be obtained. In other cases, a grooved girder rail should be used. The weight should be not less than 70 lbs. per yd. for T-rails, or 90 lbs. for girder rails. A standard return circuit system, with supplementary return, was recommended. In regard to wheels, axles, journals, journal boxes, etc., the recommendations were stated to be based on the M. C. B. rules. The President referred to the special importance of the adoption and use of standards, in view of the steady increase in consolidation of lines, and the report was accepted without discussion, although it had not been printed in advance and was not read in full.

STEAM TURBINES.

A paper on "The Steam Turbine, and Its Commercial Aspect," was presented by Mr. Edward H. Sniffin, of Westinghouse, Church, Kerr & Co. This started an animated discussion. We postpone an abstract of this to a later issue.

THE ADJUSTMENT OF DAMAGE CLAIMS.

This paper was by Mr. M. B. Starring, of the Chicago City Ry., and its special purport was to advise that all cases should be settled on the basis or merit or liability alone, without regard to "influence;" and further that cases should never be settled with the cheap attorneys who make a specialty of personal injury cases. Mr. Beggs (Milwaukee El. Lt. & Ry. Co.) strongly endorsed the recommendations of the paper. On his road politicians and individual directors formerly used to influence decisions, but he has put a stop to this entirely.

SIGNALS FOR URBAN AND INTERURBAN RAILWAYS.

This brief paper by Mr. G. W. Palmer, of the Old Colony St. Ry., Boston, is printed on another page of this issue. Unfortunately the paper was not discussed, as it came so near the end of the meeting. The President, Mr. Vreeland, referred, however, to the vital importance of proper car dispatching and car protection on interurban lines. In his experience he had found that severe head collisions between electric cars are more disastrous in causing death and injury than collisions on steam railways. One member spoke of abandoning the telephone dispatching system in favor of the telegraph, and there is such a tendency for unauthorized persons to use the telephone.

DISCIPLINE OF EMPLOYEES BY THE MERIT SYSTEM.

This paper was by Mr. W. A. Satterlee, of the Metropolitan St. Ry Co., of Kansas City, Mo. An extract is given below:

The merit system of discipline as applied by managers of steam railways seems to fill a long-felt want in street railway discipline. Certainly no system has been adopted that is fairer to the trainmen, or is more likely to produce in them a desire to keep their records clean.

There are many trivial acts, small in themselves, committed by trainmen in handling passengers, that as a whole tend to produce a feeling on the part of the traveling public either favorable or unfavorable to the company, which once formed is hard to offset. Small acts of courtesy toward passengers by trainmen are felt by the management in ways unknown to the men who perform these acts, and are as far-reaching for the good of the company as small acts of discourtesy are damaging. To teach employees to be guarded in their talk, their acts, and their deportment on duty toward those with whom they come in contact, is a problem more nearly solved in the merit system than in any other way.

In brief, the system consists of a debit and credit account with each trainman, kept in a book ruled for that purpose, or in alphabetical files; his violation of rules being charged against him by a certain number of demerit marks, the number for any one offense depending upon its seriousness. As an offset against these demerit marks, he is entitled to receive a certain number of merit marks for acts performed which would be considered by the company worthy and deserving of recognition. If at any time within one year the demerit marks exceed the merit marks by a certain number fixed upon by the company, then the party receiving them is liable to discharge.

The company with which I am connected posts at each reporting place a list of violation of rules, with the number of demerits imposed for each, and also a list of acts considered worthy of merit, with the number of merits given for each. A blank notice, made in carbon copy which is filed in the office, is sent to each trainman (with his name filled in the blank space) whenever he gets demerits or merits. The old system of lay-offs and fines has been done away with and the service much improved in the short time the new system has been in vogue, since June 1, 1902.

Mr. Harrington said he had tried and abandoned both the suspension and the merit systems, and had adopted the promotion system; under this, a man is advanced or set back according to his record. This closed the proceedings.

OFFICERS AND PLACE OF MEETING.

The list of officers presented by the Nominating Committee was adopted unanimously, as follows: President, J. C. Hutchins, President of the Detroit United Ry.; 1st Vice-President, W. Caryl Ely, President of the International Electric Ry., Buffalo, N. Y.; 2d Vice-President, W. Kelsey Schoeff, President of the Cincinnati Traction Co.; 3d Vice-President, P. S. Arkwright, President of the Georgia Railway & Light Co.; Atlanta, Ga.; Secretary and Treasurer, T. C. Penington, Chicago City Ry. The only place suggested for the next meeting was Chattanooga, Tenn.; but the selection was referred to the Executive Committee.

ENTERTAINMENTS AND EXHIBITS.

The entertainments included a reception, a theatre party, and an electric railway trip in Mount Clemens and the Country Club, where lunch was served. The annual banquet was held Oct. 10, when the new officers were installed. As is customary at the meetings of this association, the official badges distributed entitled their wearers to ride free on any city and interurban cars. This was a courtesy tendered by the Detroit United Ry. Co. and connecting lines. The exhibits were extensive and comprehensive, ranging from electrical supplies and hardware to large rotary converters in operation, and some interurban and private electric cars of large size and elaborate finish. Some notes of these are given elsewhere.

No. 16.

go near the
Mr. Free-
impo
otect
had found
lectri cars
and injury
ne member
dispat ching
ere is such
to use the

HE MERIT

lee, of the
y, Mo. An

oy manager
ant in street
been adopted
y to produce

selves, com-
t as a whole
he traveling
e company,
cts of cour-
oy the man-
erform these
he company
o teach em-
s, and their
hey come in
the merit

edit account
hat purpose,
ing charged
marks, the
seriousness,
entitled to
s performed
worthy and
n one year
a certain
arty receiv-

sts at each
the number
f acts con-
erits given
y which is
his name
emerits or
has been
ved in the
since June

bandoned
ems, and
er this, a
g to his

ING.
minating
follows:
e Detroit
aryl Ely,
Ry., Buf-
Kelsey
tion Co.;
sident of
nta, Ga.;
Chicago
the next
selection

TS.
ption, a
trip in
, where
vas held
lled. As
ociation
ir wear
an cars
Detroit
The ex-
ranging
arge ro
erurban
d elabo
en else

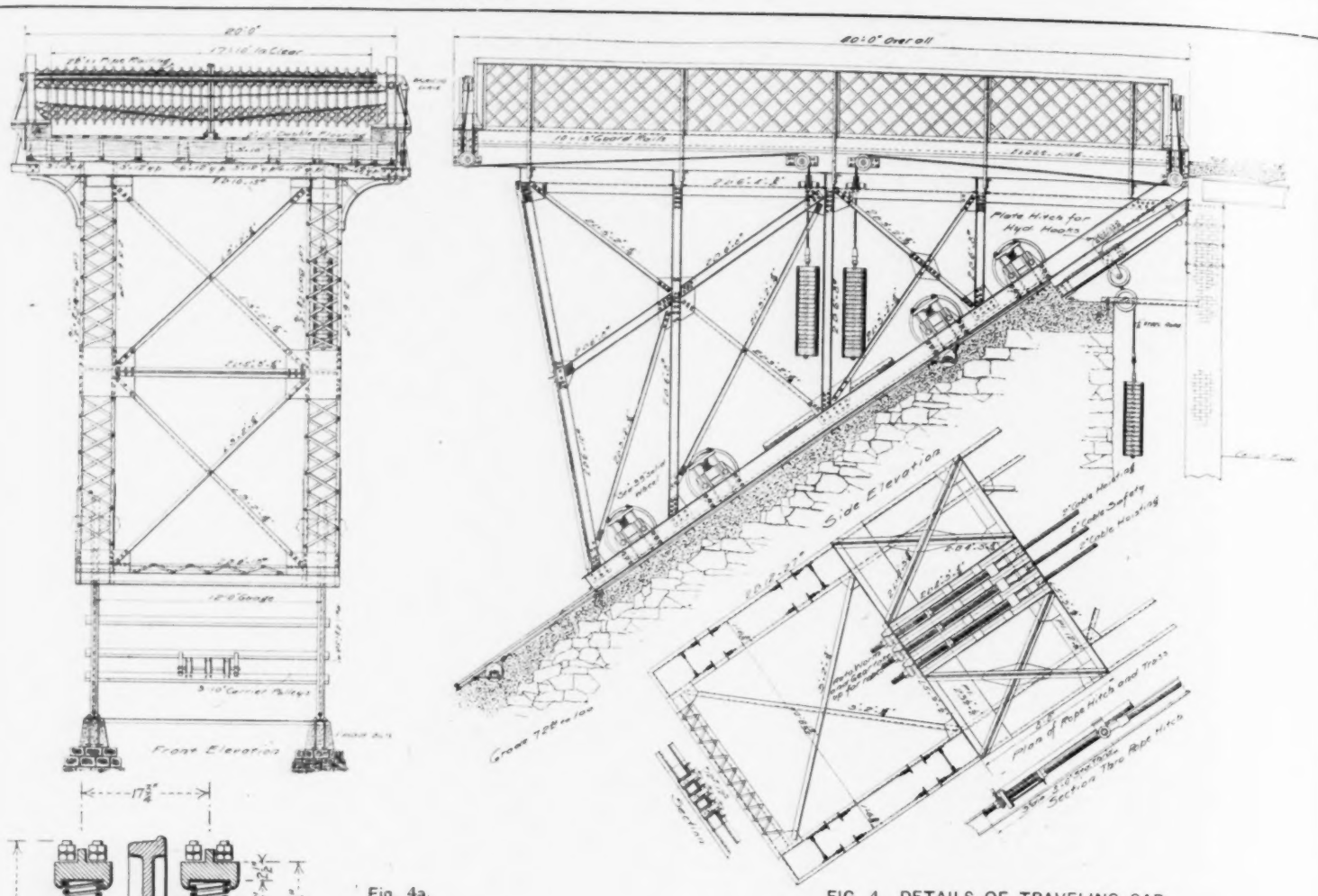


FIG. 4. DETAILS OF TRAVELING CAR.

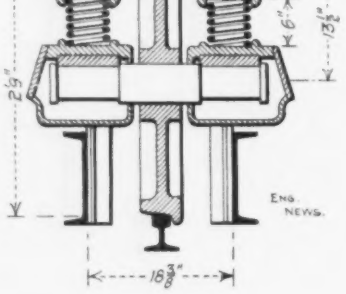


Fig. 4a.
Detail of
Wheel Support.

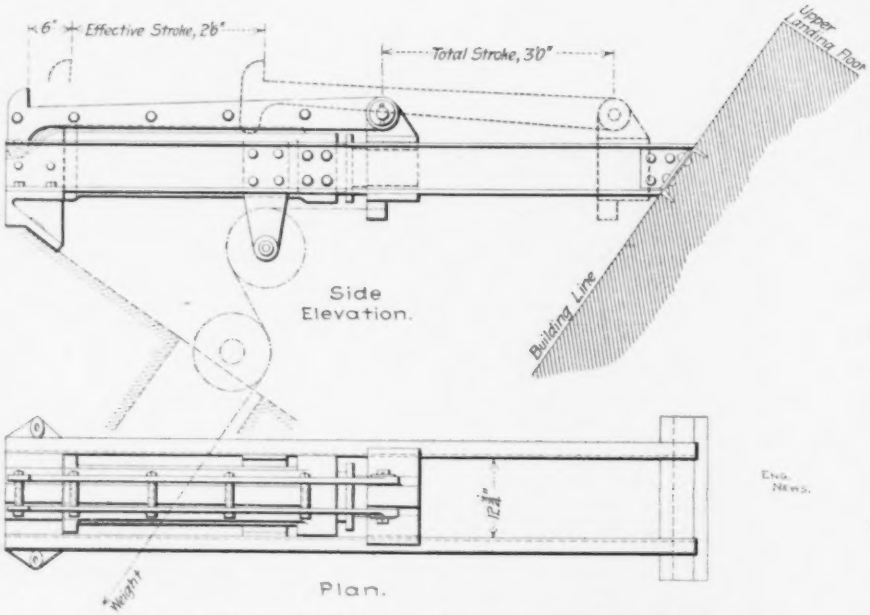


FIG. 9. CONSTRUCTION OF HYDRAULIC LANDING RAM.

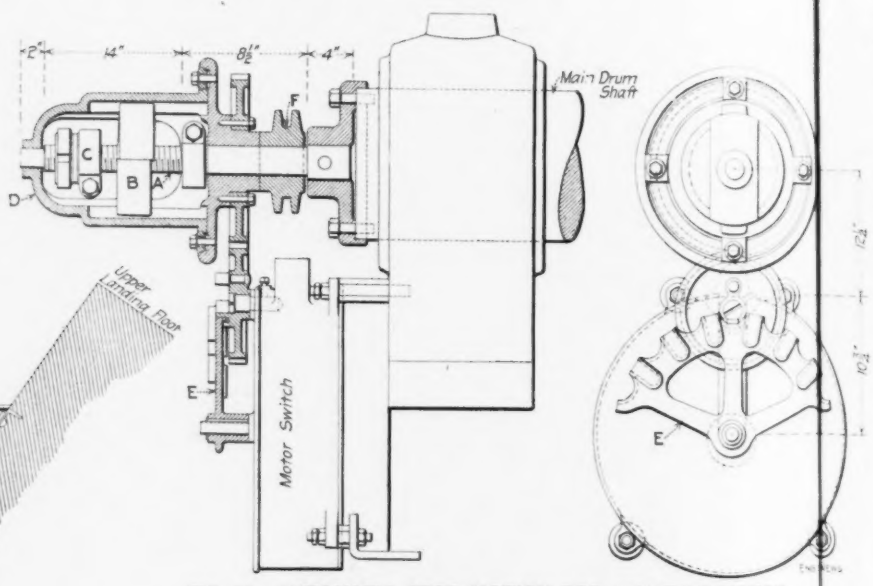


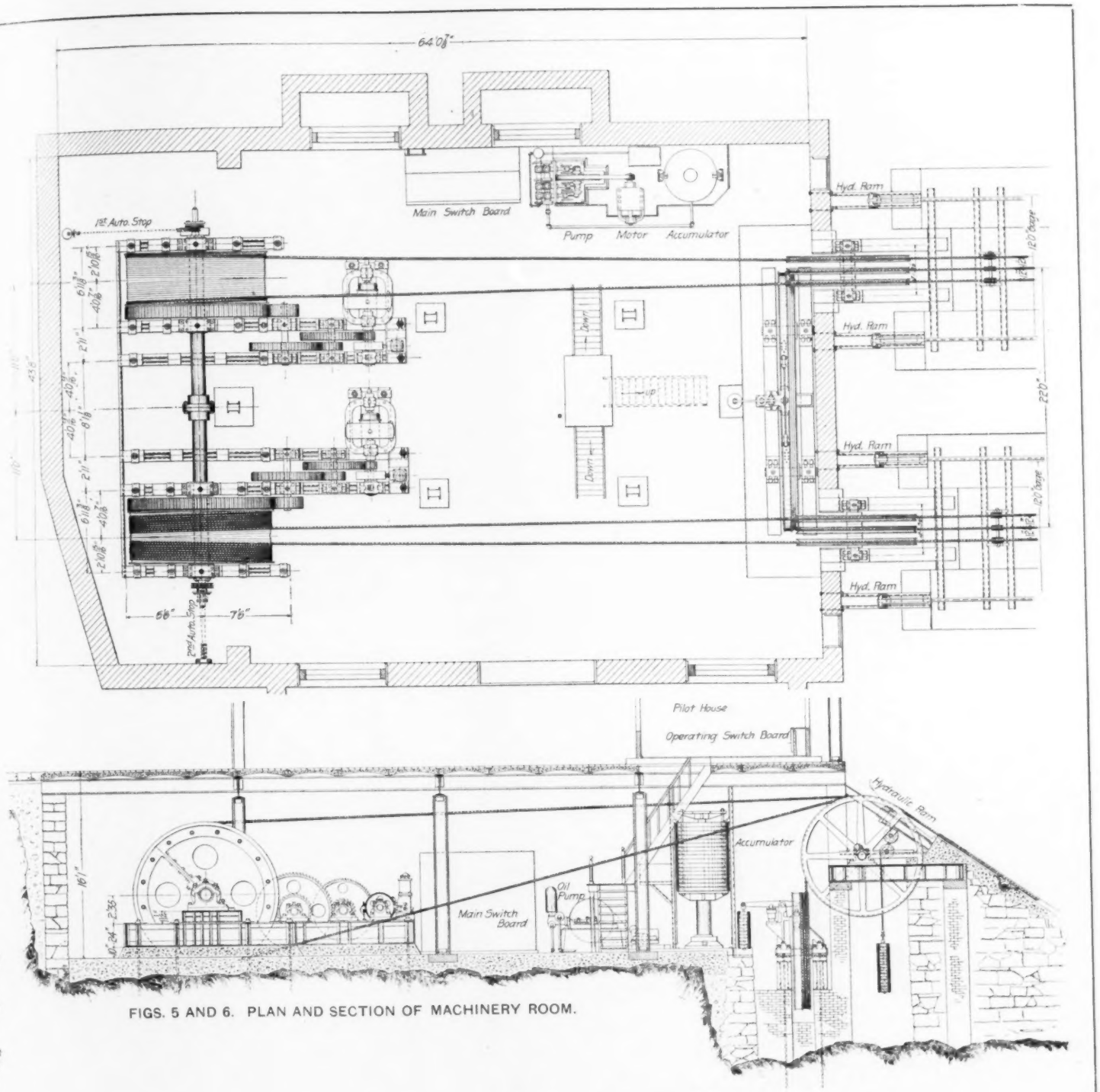
FIG. 13. AUTOMATIC STOP MOTION FOR HOISTING MOTOR.

THE WEEHAWKEN INCLINED R

Thos. H. McCann, Enginee

Sandford & Stillman Co., General C

Otis Elevator Co., Contractors for M



FIGS. 5 AND 6. PLAN AND SECTION OF MACHINERY ROOM.

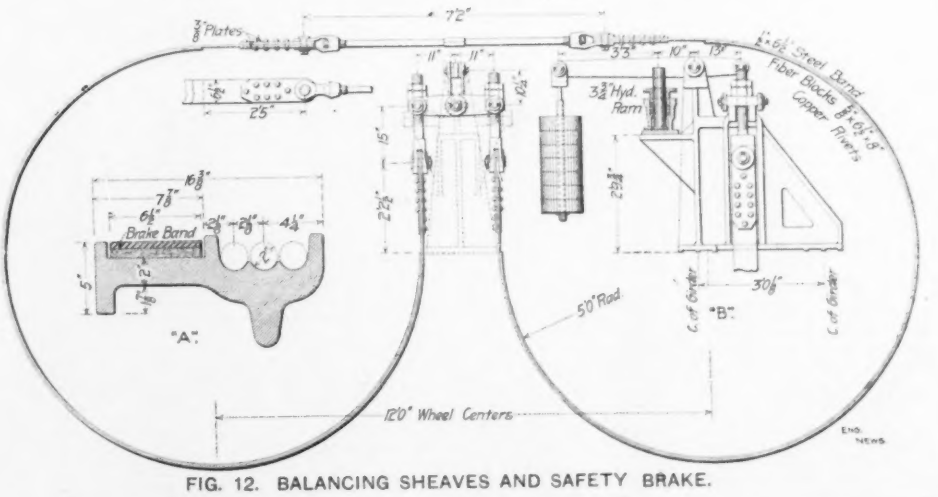


FIG. 12. BALANCING SHEAVES AND SAFETY BRAKE.

MOTOR.

KEN INCLINED RAILWAY.

McCann, Engineer.

an Co., General Contractors.

Contractors for Machinery.